

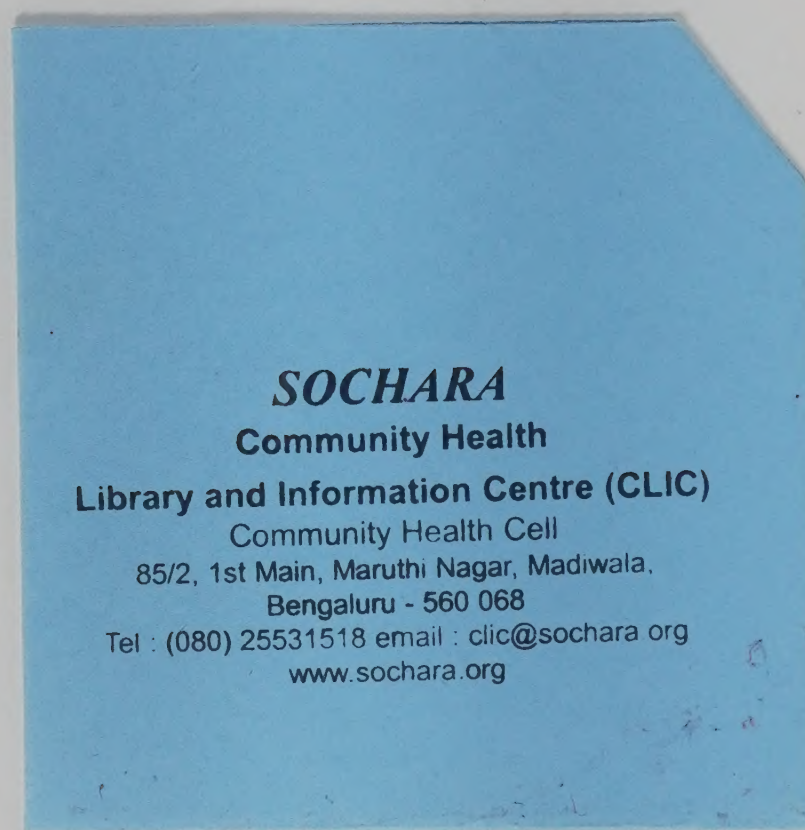
HEALTH RESEARCH POLICY AND SYSTEMS

ADVANCING THE APPLICATION OF SYSTEMS THINKING IN HEALTH

SERIES EDITOR
Taghreed Adam

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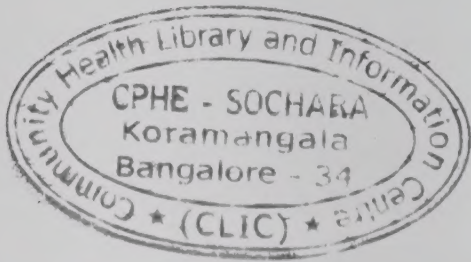
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EDITORIAL

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Advancing the application of systems thinking in health

Taghreed Adam

Editorial

Highlighting the growing significance of systems thinking in health: introducing a new global series

The past two decades have witnessed an increased recognition among global health stakeholders of the importance of systematically considering the complex adaptive nature of health systems to better anticipate some of the unexpected and counterintuitive consequences of implementing current and new policies. This is evidenced by the increased interest in topics such as systems thinking, complex adaptive systems, and systems science in the published health literature over the past 20 years (Figure 1). However, the majority of these publications are from high-income countries, while the need for applying these concepts is at least as great in low- and middle-income countries (LMICs) (Figure 2). Most of these studies discuss the concepts or make the case for the utility of systems thinking for health systems strengthening; there is still a dearth in practical guidance on how systems thinking concepts, approaches, and tools can be applied in health systems research and practice to reach sustainable solutions [1,2].

Systems thinking is, foremost, a mindset that views systems and their sub-components as intimately interrelated and connected to each other, believing that mastering our understanding of how things work lies in interpreting interrelationships and interactions within and between systems [1,3,4]. It is a perspective that deliberately goes beyond events, to look for patterns of behavior and the underlying systemic interrelationships which are responsible for these patterns and their associated events [5]. It embraces the understanding of open systems as complex adaptive systems that are constantly changing, resistant to change, counter-intuitive, non-linear, and where the whole is greater than the sum of the parts [3].

The Alliance for Health Policy and Systems Research (hereafter called the Alliance) has been one of the avid

advocates for moving this kind of thinking forward, dedicating a number of activities and resources to promote this field among health practitioners and researchers. First, through its flagship publication on “*Systems Thinking for Health Systems Strengthening*” in 2009 [5], followed by a Journal Supplement in *Health Policy and Planning*, in 2012, it has sought to generate better understanding of current practices in applying systems thinking for health systems in LMICs [1].

The 2012 supplement demonstrated the dearth of applications that explicitly took into account the complexity and dynamics resulting from intervening in health systems, including evaluations of interventions with system-wide effects [2]. In addition, the very few applications that existed at the time of developing that supplement were predominately from high income countries [1]. These observations revealed the need for concerted efforts to advance the application of systems thinking in health, particularly in LMICs.

In March 2013, the Alliance, in collaboration with Canada's International Development Research Centre, launched a Call for papers inviting teams of researchers and health practitioners, with particular focus on lead authorship from LMICs, to develop and share applications of systems thinking methods and approaches, culminating in this Series. This whole program of work, which spanned over two and a half years, provided a great opportunity for strengthening programs, policies, and methods in LMICs to enable researchers and decision makers to think through how systems thinking approaches can be applied to their current health systems questions with practical results.

It is worth noting that, while this collection of articles offers innovative and diverse range of applications of systems thinking approaches, methods, and tools, as the Commentary by Peters illustrates [6], these applications by no means capture the entire range of relevant tools and approaches that can be applied.

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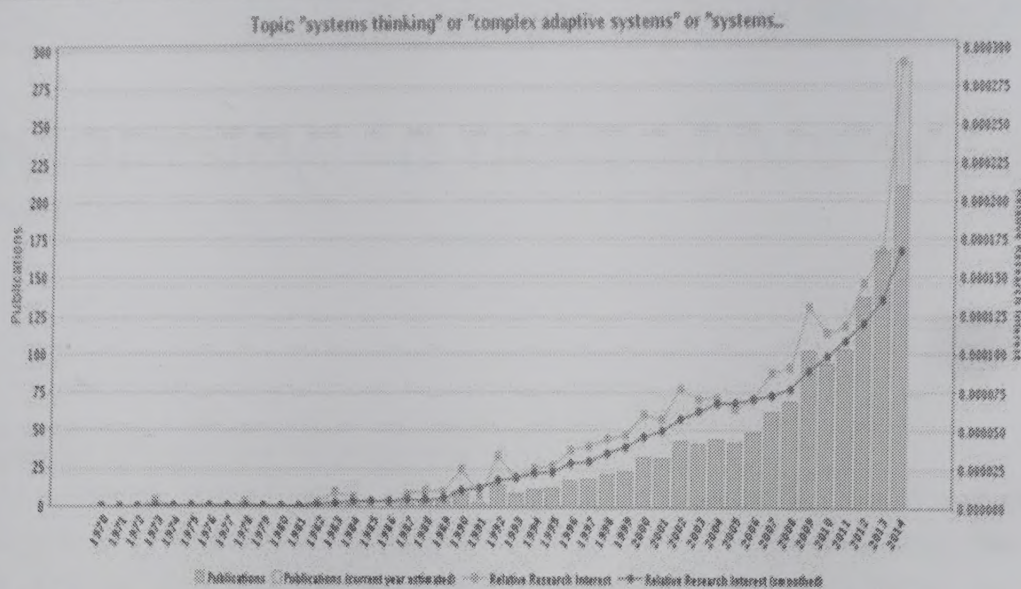


Figure 1 Trends in the use of the terms “systems thinking”, “complex adaptive systems”, or “systems science” in the Medline database over the past 40 years. Source: GoPubMed, which reports the frequency that terms appear in MEDLINE indexes for publications, which include titles, abstracts, journal names and corresponding author’s affiliation. Number of publications mentioning these search terms was 1386 as of 14 August 2014.

The applicability of a wide range of tools and approaches

This Series illustrates how research approaches that are commonly used in various disciplines, such as realist evaluation, sense-making (as a mental model), or program evaluation theories, can be applied within a systems thinking approach to address complex health systems questions. It does so by showing that the types of questions asked are the most important element that shape the orientation of the analysis, not the tool itself.

For example, in the paper by Prashanth et al. [7], systems thinking and complex adaptive systems approaches added depth to the realist evaluation by digging deeper into the drivers of, and the context in which the differences in responses of health workers in the two sub-districts were observed and what triggered them. They could show that settings with committed staff and positive intentions to make changes demonstrated more

positive outcomes and an ability to use existing opportunities to solve problems and improve performance. Further, that commitment alone was neither crucial nor sufficient as demonstrated by findings from another setting with committed staff but different outcomes. Finally, that in settings with a lack of commitment from staff, strong leadership became more pronounced in driving the change into better outcomes [7].

Systems thinking and mixed methods

As discussed by Peters and demonstrated by several of the Series papers, both qualitative and quantitative methods contribute in their own way to our understanding of complexity [6,8]. As some of the early systems thinking literature originated from quantitative disciplines such as physics and biology, it may give the impression that relevant systems thinking approaches are



Figure 2 World map of the 1,386 MEDLINE records mentioning the terms “systems thinking”, “complex adaptive systems”, or “systems science”. Source: GoPubMed, which reports the frequency that terms appear in MEDLINE indexes for publications, which include titles, abstracts, journal names and corresponding author’s affiliation. This data was obtained on 14 August 2014.

predominantly quantitative. Perhaps one of the main contributions of this Series is demonstrating how qualitative methods commonly used in fields such as social science or anthropology add equally important value and depth to analyses of complex health systems questions and phenomena [8-12]. For example, they are often used to provide a profound initial understanding of the problem that can then be complemented by quantitative approaches that incorporate the learning into a more realistic and sophisticated quantitative analysis [6].

Exploiting the potential of visual interpretations of complex phenomena

During the past decade there has been a revolution of infographics due to the increased recognition of the power of graphics to aid data interpretation and decision making. In this Series, several papers illustrate how a range of graphic tools can help convey complex interpretations and findings in a meaningful visual form, namely causal loop diagrams [8-12], stakeholder network analysis, and sociographs [13,14].

For example, causal loop diagrams used by Rwashana et al. to understand the causes of neonatal mortality in Uganda not only helped analyze and make sense of the different sources of data in a dynamic and iterative way, they were also used to present these complex findings in one main diagram that summarized the relationships, dynamics, and associated factors all in one graph [8].

Another example of visual interpretations is presented in Malik et al., where they used sociographs to interpret the pattern of advice-seeking behavior among primary health care physicians and the potential explanations for their choices [13].

Content of the series

The Series covers a range of systems thinking methods, tools, and approaches, including system dynamics modeling [15], causal loop diagrams [8-12], and social network analysis [13,14]. In addition, several papers couched their analysis in a complex adaptive systems framework [9,10,16], or adapted established methods, such as realist evaluation [7,12] and policy analysis [16,17], to untangle the underlying complexity of their research questions. The main approaches, research questions, and findings of the Series papers are discussed in turn below.

The paper by Bishai et al. uses a system dynamics simulation model to illustrate trade-offs and unintended consequences in allocative funding decisions to curative versus preventive care [15]. The model provides a quantitative application of complex adaptive systems methodologies to a health systems and policy question, something that traditional cost-effectiveness analysis techniques fail

to illustrate. In this paper, the authors demonstrate how the growth of curative care services can crowd both fiscal space and policy space for delivering population-level prevention services, which would require extensive and long-term interventions to overcome the fiscal and population health consequences [15].

The paper by Prashanth et al. is one of three papers exploring capacity strengthening initiatives targeting health workers and managers [7]. They use realist evaluation to explore how a capacity building intervention for district health managers implemented in two different places evolved over time, taking into account the context and the mechanism of change. The paper highlights the importance of the people involved and the choices they make in the evolution of outcomes, and how individual and organizational attributes and the interaction between them contribute to any particular outcome [7].

Kwamie et al. is another paper looking at capacity strengthening of middle-range managers [12]. The authors also used realist evaluation, supplemented by visually interpreting their findings using a causal loop diagram, to examine how and why a Leadership Development Programme works when it is introduced into a district health system and whether or not it supports systems thinking in district teams, using Ghana as a case study. They conclude that the leadership program on its own did not lead to the development of a systems thinking approach in management and decision-making in the district and argue that the complexity of organizational contexts and history are important influencing factors for the sustainability or scaling up of such programs, as much as the complexity of the intervention itself [12].

Gilson et al. stimulate wider thinking about the forms and practices of health leadership [17]. They use the concepts of sense-making and discretionary power drawn from the theories of complex adaptive systems and policy implementation to highlight how important it is that health system actors are able to make sense of the intentions of policies to be able to incorporate them into their everyday routines and practices. The study reveals how the collective staff understanding of their working environment, and how changes occur within it, may act as a barrier to centrally-led initiatives to strengthen capacities [17].

Next, in an application of social network analysis, the study by Malik et al. describes the formal and informal ways in which primary care physicians in Pakistan access information [13]. By employing a range of research methods, the paper examines the reasons for the disparity between organizational structures for supervisory and reporting relationships and the actual behavior of primary care physicians when seeking information. They argue for the importance and value of exploring the supervisory and technical support arrangements from the view point of the users [13].

In the paper by Paina et al. [9], the authors investigate how, in a context of no official government policy on dual practice, this practice is currently being regulated in Uganda through a system of “unwritten” expectations and local management practices that have not been elsewhere documented. Through a series of causal loop diagrams and historical and primary accounts, the authors depict the resulting behavioral patterns and complex systems characteristics such as policy resistance in the form of protests by government providers and coping approaches by providers and their managers to maintain public sector’s service delivery and performance [9].

Rwashana et al. offer another application of causal loop diagrams in exploring the complexity which characterize neonatal health and its interplay with health systems factors, using Uganda as a case study [8]. The analysis revealed multiple feedback loops, such as trust, that household place on the health system, awareness of the benefits of antenatal and postnatal care, myths, frustration of health workers and its impact on all aspects of their performance, among others. The authors also discuss high leverage points that may be considered by policy makers to improve neonatal health such as gender considerations related to girls education and empowerment [8].

Next, in their analysis of the causes of reductions in coverage of vaccination in Kerala, Varghese et al. demonstrate how important it is that the evidence used to design and evaluate public health programs goes beyond epidemiological and economic analysis [10]. The paper shows how key factors that contributed to the unexpected decline in vaccination coverage were revealed such as how the opposition by the government medical doctors association and alternative medicines proponents, compounded by strong media influence, have evolved overtime and created a big unexpected influence on people’s decision to vaccinate [10].

The following two papers explore experiences with two financing schemes in Ghana and China. In their analysis of the Ghana National Health Insurance Scheme, Agyepong et al. suggest that relatively less attention seems to be paid to service access and service responsiveness when evaluating an insurance scheme [11]; something that people thinking about enrolling consider as much as the financial risk protection potential. They highlight why a comprehensive systems thinking approach is essential when conceptualization and designing a health insurance scheme to avoid the emergence of counterintuitive and undesired effects [11]. Zhang et al. offer another perspective of a financing intervention, by exploring the evolution of rural finance schemes in China [16]. The paper discusses the nature of health systems resilience facing the implementation problems associated with the policy and argues that initial trajectories have been a big

determinant of how policy-makers adapted in the various contexts [16].

Blanchet et al. examine sustainability in internationally-initiated programs in their comparison of sustainability-oriented processes in two rehabilitation centres in Nepal and Somaliland [14]. The paper shows how differences in the governance and network structure of the rehabilitation centres, revealed through a stakeholder network analysis, have influenced the process and commitment to sustainability. The analysis helped in the understanding of change in the nature of relationships between actors and their capacity to work together over time and what factors are conducive to providing the right incentives to work as an interrelated network rather than as individual actors [14].

In second paper addressing sustainability issues, Sarriot et al. examine how an international NGO worked with two Bangladeshi municipal health departments to intentionally advance sustainability in their support for maternal and child health preventive services [18]. The paper explores how systems thinking was used to generate a process of change within municipal health systems, affecting technical, social, political, and organizational sub-systems. The authors document how a sustainability framework method was used to work with stakeholders in an explicit process to guide their decisions and choices during and after the life of a project. They illustrate how this process offered useful tools to engage stakeholders, give shared meaning to information about activities and achievements, facilitate decision making, and mitigate the risk of unintended project effects in order to achieve a measure of sustainability in a complex setting [18].

Last but not least, the commentary by Peters discusses which of the large body of theories, tools, and methods associated with systems thinking are more useful to understanding the behaviour and complexity of health systems [6]. It also discusses the “jungle” of terminology surrounding this field and how and why some terms have emerged and been used differently in different disciplines. It then provides a helpful overview of a wide range of systems thinking theories, methods, and tools that are relevant to understanding and exploring health systems questions [6].

Looking forward

With the selection of papers in this Series, our aim was to give meaning to abstract concepts and theories through actual applications and experiences of how systems thinking tools and concepts can be used to understand and strengthen health systems, particularly in LMICs. We hope that by providing a variety of experiences, examples, and ideas that are relevant to other complex interventions and contexts, this collection will stimulate wider applications and innovations of these and other approaches relevant to this field.

Competing interests

The author declare that they have no competing interests.

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RESEARCH

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Advancing the application of systems thinking in health: why cure crowds out prevention

David Bishai^{1,3*}, Ligia Paina², Qingfeng Li^{1,3}, David H Peters² and Adnan A Hyder^{2,3}

Abstract

Introduction: This paper presents a system dynamics computer simulation model to illustrate unintended consequences of apparently rational allocations to curative and preventive services.

Methods: A modeled population is subject to only two diseases. Disease A is a curable disease that can be shortened by curative care. Disease B is an instantly fatal but preventable disease. Curative care workers are financed by public spending and private fees to cure disease A. Non-personal, preventive services are delivered by public health workers supported solely by public spending to prevent disease B. Each type of worker tries to tilt the balance of government spending towards their interests. Their influence on the government is proportional to their accumulated revenue.

Results: The model demonstrates effects on lost disability-adjusted life years and costs over the course of several epidemics of each disease. Policy interventions are tested including: i) an outside donor rationally donates extra money to each type of disease precisely in proportion to the size of epidemics of each disease; ii) lobbying is eliminated; iii) fees for personal health services are eliminated; iv) the government continually rebalances the funding for prevention by ring-fencing it to protect it from lobbying.

The model exhibits a "spend more get less" equilibrium in which higher revenue by the curative sector is used to influence government allocations away from prevention towards cure. Spending more on curing disease A leads paradoxically to a higher overall disease burden of unprevented cases of disease B. This paradoxical behavior of the model can be stopped by eliminating lobbying, eliminating fees for curative services, and ring-fencing public health funding.

Conclusions: We have created an artificial system as a laboratory to gain insights about the trade-offs between curative and preventive health allocations, and the effect of indicative policy interventions. The underlying dynamics of this artificial system resemble features of modern health systems where a self-perpetuating industry has grown up around disease-specific curative programs like HIV/AIDS or malaria. The model shows how the growth of curative care services can crowd both fiscal and policy space for the practice of population level prevention work, requiring dramatic interventions to overcome these trends.

Introduction

Achieving optimum health of a population requires an artful combination of preventing ill health and responding to disease cases with curative services. Both are important, but there are predictable obstacles to achieving balance. Too often, only a single, limited government health

budget is available for investments in both non-personal preventive and curative personal health services. A variety of influences affect the allocation of this common health budget [1]. Ideally, these factors include efficiency and equity. In reality, concerns also include policy and political priorities, which often take precedence over efficiency and equity criteria [2]. This struggle between evidence-based decision-making to achieve health system goals and the reality of policy and financing constraints occurs in a variety of contexts besides government health ministries.

Fixed government health budgets lend themselves to a zero-sum game in resource allocation between cure and

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prevention. More spending on curing diseases will mean less for prevention and vice versa. It is observed with regularity, in both high-income and low- and middle-income settings, that whenever there is a fixed sum to be allocated between curing and preventing diseases, a higher total will be spent on curing than preventing, and more will be spent per disability-adjusted life year (DALY) averted by curing than preventing [3-6]. For example, although the burden of disease associated with chronic, non-communicable diseases is significant, in the Organization for Economic Co-operation and Development countries average expenditure on public health and prevention for non-communicable diseases was only 3% of the total health expenditure in 2005, while average expenditure on curative care was 57% [7]. The situation can be even direr in developing countries, particularly in sub-Saharan Africa, where the large urban hospitals often receive at least half of the public funds spent on health [8].

Spending more money per DALY averted on curing than preventing violates both efficiency and equity goals. It violates efficiency standards by definition. If intervention P saves more lives per incremental dollar than intervention C then a shift of spending from C to P will save more lives but it will not cost more. It also violates equity standards because access to curative services is often achieved preferentially by those with greater social privilege [9]. The preventive interventions we consider here are delivered to a population en masse rather than in individual clinical encounters and they have been shown to decrease population health disparities and increase health equity [10,11].

Preventing is not always more efficient than curing. Many preventive health care procedures delivered to individuals in clinics are not uniformly more cost-effective than curative clinical services [12]. However, most preventive interventions are not clinical procedures, they are community and environmental interventions mounted by public health entities. By shifting the environmental and social determinants of health for populations millions at a time, public health expenditures are typically best buys in health [13].

This paper analyzes a process whereby a neutral policy change undertaken in the name of efficiency can lead to a spiraling increase in the power of groups whose self-interest will block rational and efficient allocation of public resources in the future. A standard decision analysis of option A vs. option B will be inadequate if option A commits future generations to depart from rational policy making because of the power of interest groups created by option A. To be specific, the model developed here examines how health policies may enhance the class power of curative care interests (e.g., clinicians, hospitals, medicine manufacturers) and lead to a snowball effect that exaggerates a bias to spend more towards clinically-oriented health spending in the future.

Power politics are unavoidable in health policy [14]. Examples of policy makers successfully appealing to cost-effectiveness data and not politics to rationalize their health spending portfolio are few [15]. In fact, many examples show that policy-makers do not use cost-effectiveness data to decide on budget allocation [16,17]. There are simple explanations for why decision-makers whose stated objective in budgetary allocation is to avert DALYs at lowest cost fail to actually allocate spending accordingly. Most explanations focus on the decision-makers lack of cost-effectiveness data or unfamiliarity with the paradigm [2,12]. However, the regularity of the bias towards cure and away from prevention suggests that something more structural and systematic must be at work.

The models that will yield understanding will need to encompass unintended consequences of complex adaptive systems. A growing body of literature explores the role of complexity in health systems [18-21]. For this paper, we use the principles of system dynamics modeling to develop understanding of non-linear interactions in defined systems [22]. Using system dynamics, researchers can simulate policy scenarios which cannot be carried out in real populations or for which adequate historical data on natural experiments is not available. We offer a simple model of political lobbying between the curative health care sector and public health proponents situated in a hypothetical population with a very simple epidemiological problem.

We are pursuing a form of “generative” social science—applying the adage “*if you didn’t grow it, you didn’t explain it*” [23]; being able to generate a phenomenon without pre-supposing it is the best way to understand it, and this is best done in a simulation. The model is simple enough so that we can turn parts on and off allowing readers to understand which of the dynamics emerge from the simplistic assumptions and which result from the policy experiments. The omitted complexities of real world spending and lobbying would certainly mitigate the dire consequences that befall the population in our simplified model. That underscores the advantage of the model in offering insight into processes that are harder to measure in the thicket of real world observations. The model intentionally exaggerates important aspects of the real system – the exaggeration is a feature, not a flaw.

This artificial model is not trying to fit any real-world epidemiological data. The purpose of the model is to gain understanding of elementary political forces that can be turned on and off in the model. Specifically, one can test the effect on population health of government policies that:

- i) Rationally allocate spending according to neutral cost-effectiveness criteria.

- ii) Allocate government funds proportionally to interest group lobbying or not.
- iii) Accept or refuse spending by non-governmental organization (NGO) external donors that target either disease A or B.
- iv) Allow fee-for-service revenue for curative care workers.

Methods

We model a finite population that is susceptible to only two possible unwanted health conditions. Individuals can suffer from an acute disease, called disease A, that is disabling, never lethal, and whose duration can be shortened by a visit to a doctor. They can also suffer from a sudden, instantaneously lethal condition, disease B, that can never be cured, but which can be prevented through environmental engineering by preventive care workers (PCWs) (if it helps, one can think of disease A as something like an intestinal parasite, e.g., ascariasis, and disease B as something like a bicycle crash). Disease A, if untreated, causes 100% disability for 0.5 years before recovery. Each untreated case of disease A imposes 0.5 DALYs on the population. Disease B kills each victim instantly and deprives them of 25 additional years of survival; each case of disease B imposes 25 DALYs. Both the doctors and the PCWs are supported by a fixed-sum budget allocated by the government. In contrast to the PCWs, the doctors can also collect fees from each patient who sees them after contracting disease A. Both PCWs and doctors invest a similar portion of their earnings on lobbying the government for a larger share of the fixed-sum budget. The government can be swayed by the lobbying, in which case it allocates the budget proportionally to the size of the lobbying funds of the respective two parties, e.g., if doctors account for 2/3 of all of the money spent on lobbying, they will get 2/3 of the health budget.

In the baseline mode, initial values were selected to put the model at a stable equilibrium prior to the introduction of shocks to the system. The initial baseline equilibrium does not include any external funding, and there are no shifts in incidence of either disease. In the baseline, all inflow and outflow equations are balanced perfectly. Subsequently, the response of the model to policy shocks can be fully attributed to the policy changes. A stock-and-flow diagram and simulation model was created using the VensimPLE[®] software [24]. Consistent with system dynamics methodology, there are three types of variables for each sub-system: state variables depicting levels, difference equations depicting flow rates, and auxiliary variables reflecting other parameters [22]. Our stock-and-flow model is comprised of the three subsystems described below.

The model was designed solely by the investigators during a number of team meetings by DB, LP, and QL to

redraw and recalibrate the feedback loops and adjust the parameters based on model output. Some studies in systems science are done with a specific decision-maker or institutional client in mind. In these cases, it is quite common to involve those decision-makers in helping to design the model. This engages the community of practice and research together and helps the group interpret the output of the model to jointly improve organizational policy. However, a drawback of this bespoke approach is that the better the model fits a specific problem, the less it fits a general problem. The research here is intended to be of general relevance to any setting where there is a zero sum budget that could be allocated to prevention or cure.

Subsystem 1: the population and disease model

The subsystem for the population and its experience of diseases A and B can be found in Figure 1. Table 1 presents the population parameters, initial values, and relevant assumptions. There is a stable healthy population in which a person stops being healthy either temporarily if an individual contracts disease A, from which each will recover after a certain duration determined by the activity of doctors. Population members can also exit permanently by sudden death from disease B. If they do not die of disease B, individuals will all die 25 years later through a process unspecified by the model. The population count remains stable because fertility is unimportant to the focus of the model. All deaths are immediately replaced by new healthy full grown individuals with remaining lifespans of 25 years. The duration of disease A is influenced by medical care expenditures by government (and donors) and by fees paid to doctors in exchange for curative services. Both the acquisition of disease A and death from disease B lead to increments in the DALYS lost by the population. Hence, the relative impact of one event of either condition on the DALY measure of population health is just a matter of the arbitrary DALY weights. In the baseline model, we set these weights so that the population experiences an equal burden of DALYS from diseases A and B.

The fundamental difference between the curable disease A and the preventable disease B in the model is not the DALY weights assigned to each as later shown in the sensitivity analysis. The key asymmetry between A and B is that there is no market for PCWs to charge fees for preventing disease B. Epidemics of curable diseases will fill the doctor's offices with paying customers, but an epidemic of disease B cannot generate a revenue surge in the absence of government action. This difference in the model corresponds to a difference in real health policy, especially remembering that the "prevention" that is being modeled is not clinical preventive services which can generate revenue, but community level public health activities (e.g., road hazard reduction) for which revenue

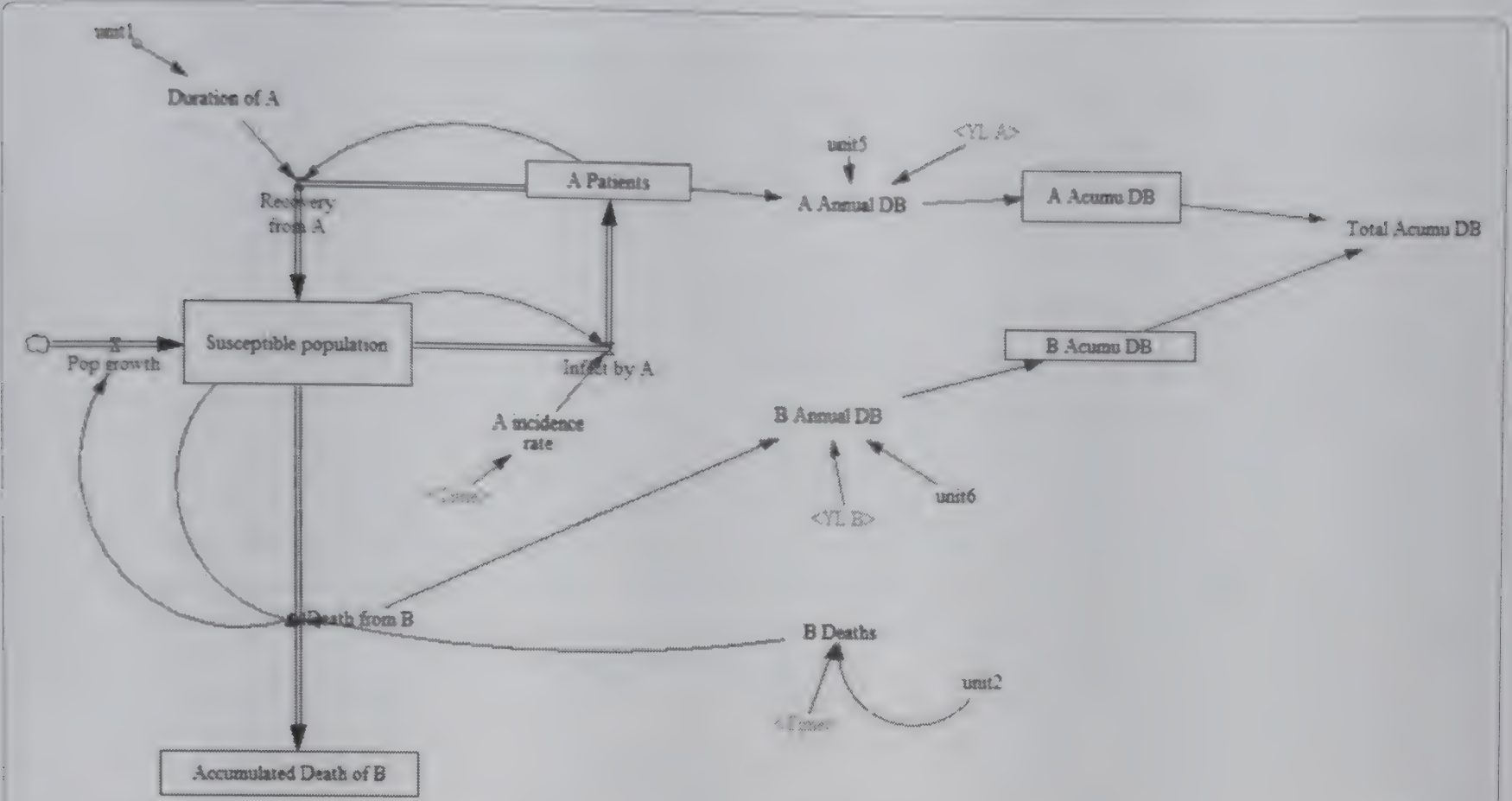


Figure 1 Subsystem 1: the population model. A susceptible population is at risk for either dying from disease B or transitioning temporarily into disease A. Abbreviations: A Acumu DB, Accumulated DALYS from A; B Acumu DB, Accumulated DALYS from B; Total Accumu DB, Total accumulated DALYS.

collection is necessarily collective. Even though real world doctors have higher incomes than PCWs, we set their baseline income to be equal in the model. The incomes become unbalanced only when we allow the doctors to charge fees to people with disease A. The assumption of equal baseline incomes helps us see exactly what is responsible for the power imbalances that will emerge. The power imbalance between cure and prevention is not assumed – the imbalance comes from policies that tie earning to curing.

Table 1 Population subsystem parameters and assumptions

Equilibrium parameters	Variable type	Initial value	Notes and assumptions
Susceptible population	State	800	Individuals
Disease A infection rate	Rate	40	Individual infected/year
Disease A patients	State	200	Infected population, at equilibrium
Disease A incidence rate	Auxiliary	0.05	Population based incidence
Disease A duration	Auxiliary	0.2	Years
Disease A recovery rate	Rate	40	All infected with disease A, recover
Death from disease B	Rate	4	Deaths/year
Accumulated death from disease B	State	0	Deaths from B, at equilibrium
Disease A annual burden	Auxiliary	100	Disease A burden at equilibrium
DALYs lost per case of disease A	Auxiliary	0.5	Constant – one untreated case of infection with A is equivalent to 0.5 years of life with disability
Disease A cumulative burden	State	0	Disease A burden at equilibrium
Disease B annual burden	Auxiliary	100	Disease B burden at equilibrium
DALYs lost per case of disease B	Auxiliary	25	Constant – one death from B is equivalent to 25 years of life lost
Disease B cumulative burden	State	0	Disease B burden at equilibrium
Total cumulative disease burden	Auxiliary	0	Sum of cumulative burden for disease A and disease B, at equilibrium

Subsystem 2: health resources

The subsystem depicting health resources and how they are allocated is illustrated in Figure 2. Table 2 presents parameters, their units, and any assumptions that are relevant for our design. The simulated health system has three principal funding sources: public funding for both PCWs and doctors, private spending for curative services only, and donor funding. Public funding is a finite source which is allocated between doctors and PCWs through a political bargaining process between the two categories of health workers vying for a finite pot of governmental health funds. Bargaining power is measured in monetary units and each group acquires “power” by paying a portion of their earnings into a bargaining fund. In a simple model of “rent-seeking” the government is influenced to allocate state resources to either group in proportion to their share of total bargaining power. Thus, allocation of the fixed health budget to C is proportional to $C/(C + P)$ and allocation to P follows $P/(C + P)$ where C is lobbying dollars spent by curative care interests and P is lobbying dollars spent by preventive care interests.

The model sets initial values such that the baseline government spending is economically optimal. At baseline, the dollars the government spends per DALY averted is exactly the same between diseases A and B. Emotional or political factors that might bias spending towards cure are not burnt in as an official part of government strategy. In addition to public funding, we set initial values so that the arrival of external aid from donors is always unbiased making the donor allocate new dollars to disease A or disease B to keep the incremental DALYS averted per dollar equal and unbiased. Such a policy is crudely feasible for donors today who could consult league tables that display comparative \$ per DALY averted from various interventions across world regions [13,25]. In the baseline version of the model, these efficient spending levels are

maintained in perpetuity because there are no epidemics that might trigger donor allocations or patient care seeking. Lobbying power and funding allocations between doctors and PCWs will remain perfectly balanced as long as incidence rates of either disease are unperturbed.

For policy simulation, the model imposes an exogenous series of epidemics of A and B as a series of step functions that raise the incidence of diseases A or B or both above the equilibrium every 3 to 4 years. The model is able to restore equilibrium after these step function epidemics because the government and/or donors immediately detect the epidemic and they rationally increase funding towards whatever disease has risen above its baseline. The government and donors are programmed to respond without bias to disease A or B. They are set to allocate the same \$ per DALY averted to disease A as is allocated to disease B during an epidemic, as long as there is no political lobbying.

Subsystem 3: doctor and PCW resource allocation

Figures 3 and 4 illustrate the final subsystem in the model – the lobbying process driven by doctors and PCWs. Table 3 presents the parameters, their units, and any assumptions that are relevant. We define political bargaining power of doctors as proportional to resources collected in a common lobbying fund by doctors out of their public and private salaries. The doctors, as a group, can then allocate the money they earn from fees, government payments, and donor payments to either improving recovery time for disease A in the infected population or to lobbying activity so they can capture more public funds. Similarly, we define PCW power as the resources amassed by PCWs from all sources, which can then be allocated to preventive services or lobbying. As mentioned above, PCW resources include public funds and donor funding, but there

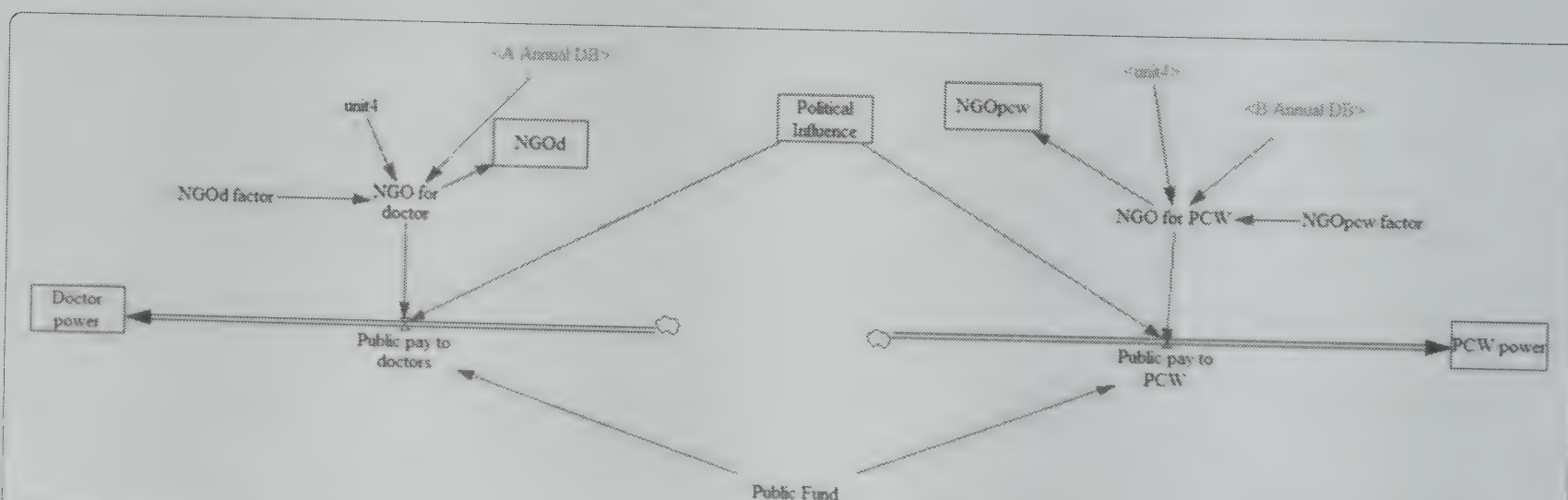


Figure 2 Subsystem 2: doctors (left) and PCWs (right) accumulate “power” in the form of earnings. A public fund (center bottom) is allocated to public payments to doctors (arrow pointing left) and public payments to PCWs (arrow pointing right). There are also two non-governmental organizations (NGOs) named NGO-D, which donates to doctors, and NGO P, which donates to PCWs. Consultation fees (bottom left) in proportion to the number of patients with disease A also supplement doctor’s earnings.

Table 2 Subsystem 2 variables and assumptions

Equilibrium parameters	Variable type	Initial value	Notes and assumptions
Public fund	Auxiliary	1250	Monetary units available, at equilibrium
Political influence	State	N/A	(Doctors spending on lobbying)/(Doctors spending on lobbying + PCWs spending on lobbying)
Public pay to doctors	Rate	N/A	(Political Influence*Public Fund) + NGO for doctor
Private pay for doctors	Rate	N/A	
Consultation fees for doctors	Auxiliary	3.75	Monetary units per treatment provided by doctor
Public pay to PCWs	Rate	N/A	Public Fund × (1–Political Influence) + NGO for PCW
NGO-D	State	0	Accumulated external funding to doctors
NGO-P	State	0	Accumulated external funding to PCWs

are no fees paid for PCWs. The entire model, showing how the sub-systems relate, is displayed in Figure 5.

Modeling scenarios

The model horizon is 200 months. During both modeling and sensitivity analyses, we tracked changes in cumulative disease burden and deaths from both diseases and cumulative spending. We used the cumulative burden of disease and the cumulative spending to produce the graphs of costs vs. DALYs averted by the various donor spending policies.

A standard run with the simulation requires observing its response to two types of simulated shocks: disease

epidemics and external funding from donors. Without shocks, the model stays in perpetual equilibrium. Epidemic times for disease A were arbitrarily selected to fall at months 13, 49, 85, and 121; each epidemic lasted one year. During an epidemic of disease A, the incidence rate increased ten-fold, from 0.05 to 0.5. Epidemic times for disease B were selected to fall at months 37, 61, 109, and 121. We tried different epidemic combinations and timings. Specifically, the system encountered an epidemic of A alone, then an epidemic of B alone, then two epidemics of A followed by B, and, finally, an epidemic of A and B together. We examined the system’s ability to contain these epidemics with and without the response of NGO donors.

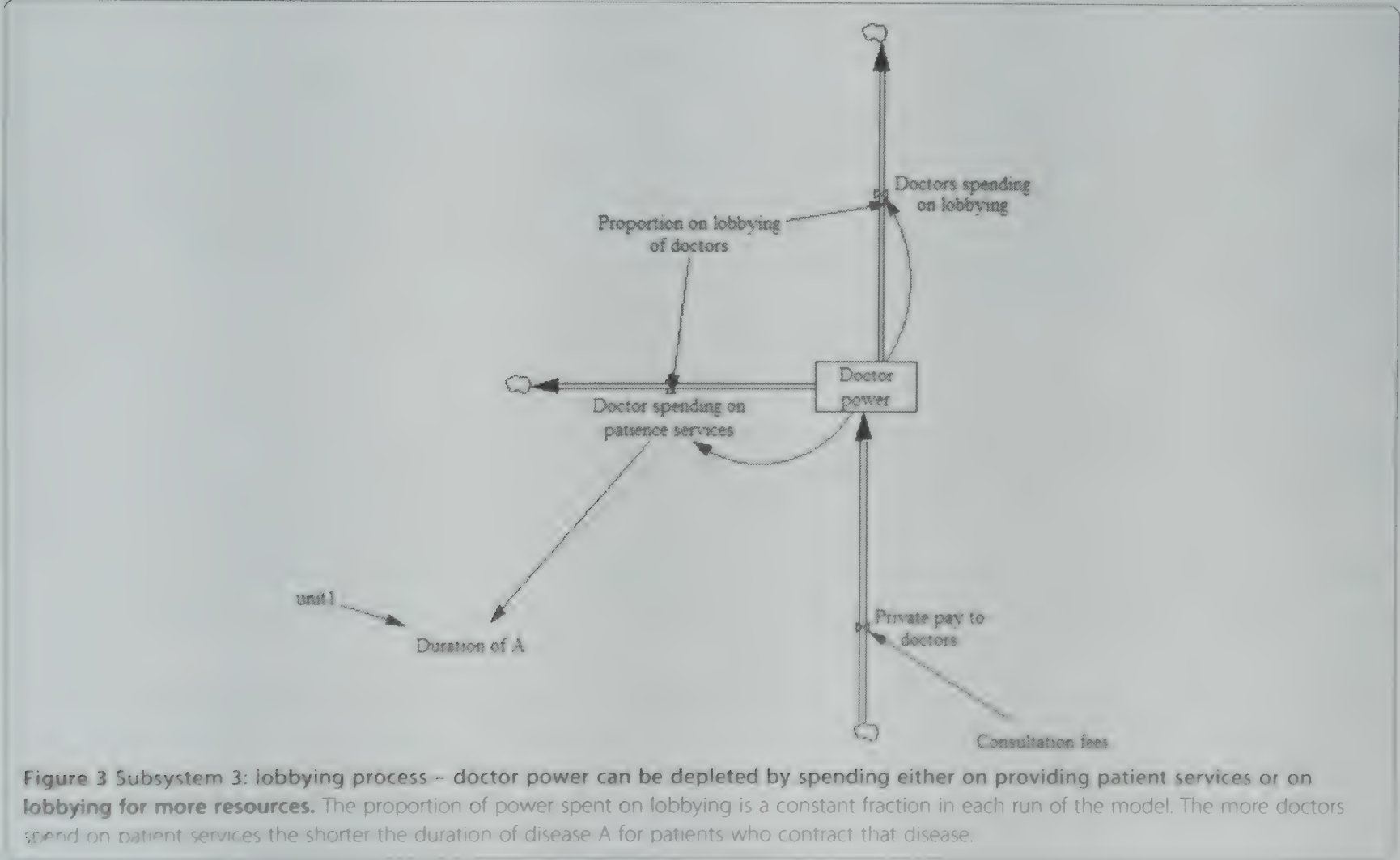


Figure 3 Subsystem 3: lobbying process – doctor power can be depleted by spending either on providing patient services or on lobbying for more resources. The proportion of power spent on lobbying is a constant fraction in each run of the model. The more doctors spend on patient services the shorter the duration of disease A for patients who contract that disease.

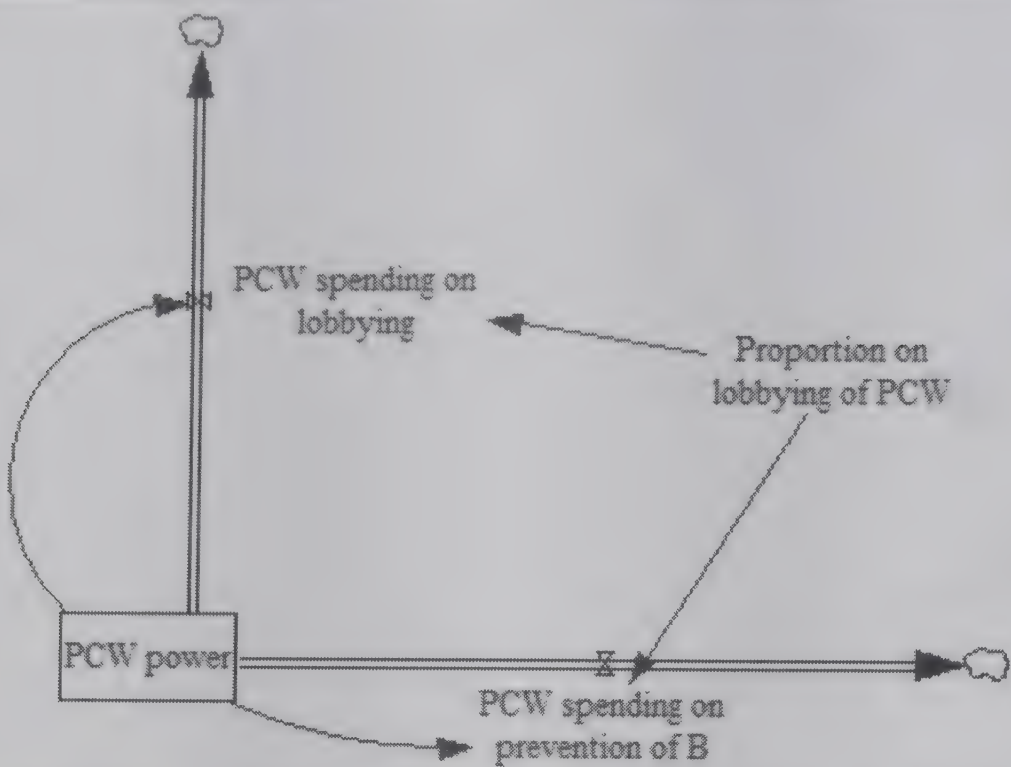


Figure 4 Subsystem 3: lobbying process – PCW power is spent on lobbying and on shortening the incidence of death from disease B. The proportion of power spent on lobbying is a constant fraction in each run of the model.

NGO donors are programmed to make donations to their chosen disease only as long as the incidence rate is higher than the equilibrium baseline level. Donation policies are specified as the number of additional dollars allocated to either disease per DALY averted. D_A was defined as the donation in terms of \$ per additional DALY of disease A after an epidemic of A and D_B as the donation in terms of \$ per additional DALY of disease B that the NGO would spend. Suppose the donation policy is $D_A = \$10$ per epidemic DALY of A and $\$D_B = 5$ per epidemic DALY of B. In an epidemic with 10 additional DALYs of A and 6 additional DALYs of B, the donations would be \$100 to A and \$30 to B. In equilibrium, D_A was set to equal D_B . There was no built-in role for donors to practice disease exceptionalism [26]. To test the effects of special pleading on behalf of either disease, we later let

donation policies become discordant and we tested donation policies with D_A set sequentially at {0, 5, 10, 20, 30, 40, 50, 60, 70} while, independently, D_B realized values from {20, 30, 40, 50, 60, 70} [27]. A donor whose policy was $D_A = 70$ and $D_B = 10$ would be indicating a bias to spend seven times as much averting a DALY from disease A relative to disease B. A total of 81 (D_A, D_B) pairs were tested and we tracked the 200 month cumulative sum of DALYS from both of the diseases and total costs to the government, patients, and NGOs as a result of the NGO's epidemic control strategies. Overall, 81 cycles were required through the 200 month trajectory of the model to fully assess a policy or parameter change. The graphical output of these policy assessments involves showing a four-dimensional manifold of costs and DALYS as co-determined outcomes of D_A and D_B . We accomplished

Table 3 Subsystem 3 variables and assumptions

Equilibrium parameters	Variable type	Initial value	Notes and assumptions
Doctor power	State	1,000	Doctor's lobbying power at equilibrium; equals PCW power at equilibrium
Doctor spending on lobbying	Rate	0	Doctor power \times Proportion on lobbying
Proportion on lobbying of doctors	Auxiliary	0.125	Doctors spent 12.5% of their resources on lobbying
Doctor spending on patient services	Rate	0	Doctor power \times (1-Proportion on lobbying of doctors)
PCW power	State	1,000	PCW's lobbying power at equilibrium; PCWs and doctors start with the same level of power
PCW spending on lobbying	Rate	0	PCW power \times Proportion on lobbying of PCWs
Proportion on lobbying of PCWs	Auxiliary	0.5	PCWs spend 50% of their resources on lobbying
PCWs spending on prevention of disease B	Rate	0	PCW power \times (1-Proportion on lobbying of PCWs)

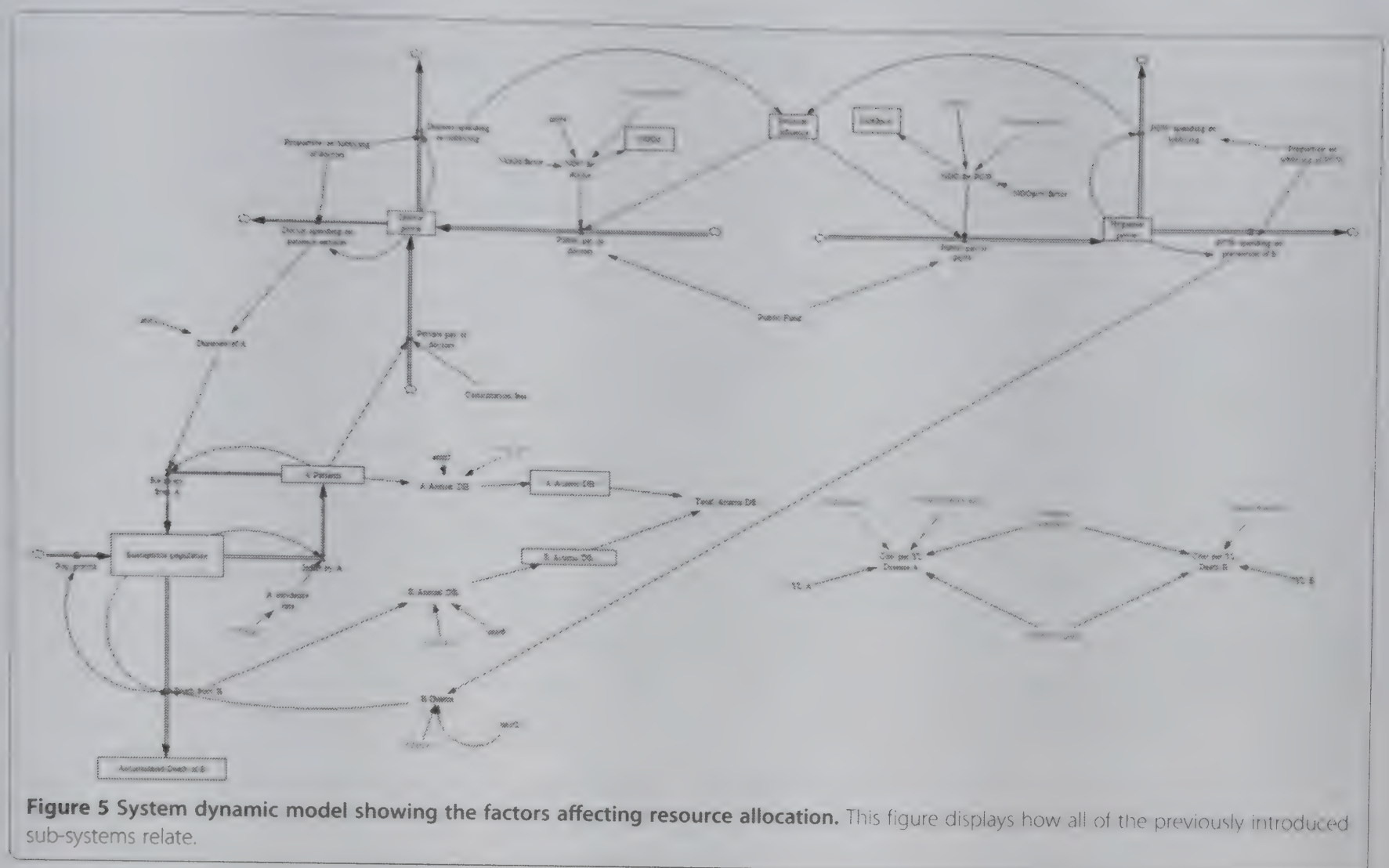


Figure 5 System dynamic model showing the factors affecting resource allocation. This figure displays how all of the previously introduced sub-systems relate.

this by showing isoquants – a locus of DALY and cost outcomes generated when D_A (or D_B) is held constant while D_B (or D_A) varies along the locus (Figures 6 and 7).

The economic problem for the NGO ought to be choosing epidemic response policy (D_A , D_B) to minimize DALYs while minimizing total cost to itself and to society. Whether or not it espouses an economic paradigm, the NGO does not want to achieve a situation where they spend more and achieve more overall deaths and DALYs due to their spending crowding out other activities in the health system. Locating attractive and unattractive values of (D_A , D_B) is our schematic version of why donors care about data on the global burden of disease and why they want data on the effectiveness and cost-effectiveness of health interventions.

Sensitivity analyses

We conducted the following sensitivity analyses in order to ensure that the results we obtained from the main model were robust to changes in the original parameters and variables:

- We let years of life lost from disability per case of disease A vary $\pm 10\%$ from 0.45, 0.5, and 0.55.
- We let years of life lost from death per case of disease B vary $\pm 10\%$ from 22.5, 25, and 27.5.

Policy analyses

We implemented three different policy scenarios to discover how various strategies might make the system work better.

- Eliminate lobbying for curative care and preventive care.
- Making the public pay responsive to burden of disease changes resulting from epidemics.
- Removing the consultation fee obtained by doctors.

Results

We found that several negative feedback loops stabilized key levels in the model. There was negative feedback restoring physician incomes to baseline after their incomes rose in an epidemic. Essentially, the epidemic gave the doctors more money, but they ultimately spent some of the money reducing the size of the caseload that generated their revenue and eventually their revenue fell. The burden of disease A was also restored to equilibrium through this negative feedback loop.

The model also showed the presence of a negative feedback loop for government to respond to epidemics of disease B with extra spending on disease B. After disease B returned to baseline, the rational government response to the epidemic stopped. In the absence of the government response to epidemics of disease B, there is no natural way

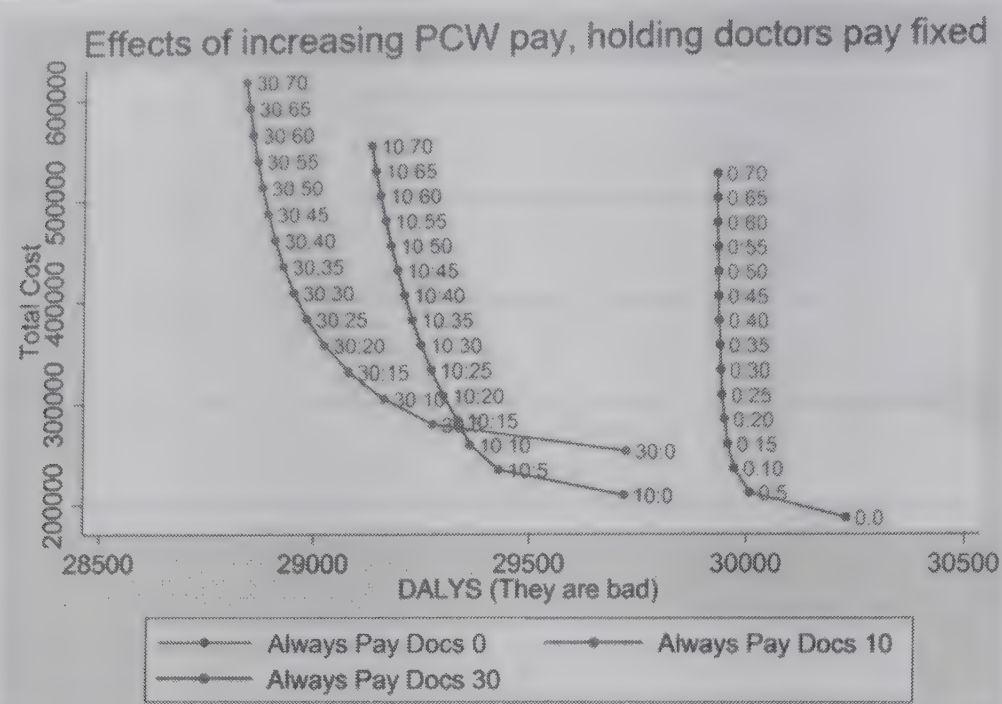


Figure 6 Baseline scenario: results of NGO donation policies at various fixed levels of NGO donation per epidemic case of disease A from 0 to 30. Points are labeled with $D_A:D_B$, which represent, respectively, the \$ per additional DALY of disease A and of disease B. At all additional payments to the prevention workers, paying more reduces the burden of disease.

the system would raise funding for PCWs to fight an epidemic of disease B and the system would simply shift to a higher disease burden and not show return to equilibrium. Figures 6 and 7 plot societal dollars spent vs. DALYs averted. Note that the optimal zone in these figures would be at the bottom left where nothing is spent and there is no DALY burden. Points that are at the far right represent high disease burden and little spending. Starting from the bottom, as more is spent there is a

rise in the vertical dimension and the DALY burden can become lower, moving to the left. As shown in Figures 6 and 7, there were diminishing returns to scale from NGOs investing in either disease – progressive amounts of money spent in the vertical dimension led to smaller and smaller reductions in DALY burden. Figure 6 shows that, with spending on doctors held fixed, more spent on PCWs had a continuously increasing incremental cost per DALY averted.

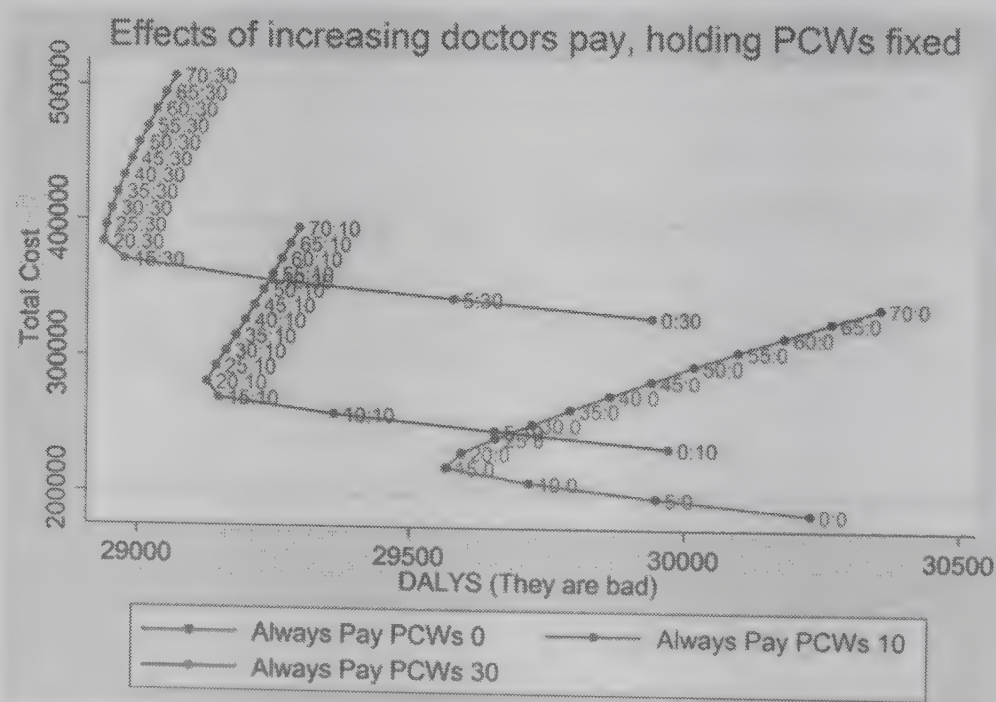


Figure 7 Baseline scenario: evidence of population harm from expanding payments to doctors. The parts of the cost effectiveness curves sloping up and to the right indicate options that cost progressively more and increase the burden of disease. These undesirable options occur beyond a threshold of \$20 per DALY of disease A. Points are labeled with $D_A:D_B$, which represent, respectively, the \$ per additional DALY of disease A and of disease B. D_B is held constant within each iso-policy curve.

Surprisingly, Figure 7 shows that spending on doctors generated negative returns with overall declines in population health per incremental \$ spent on doctors' services per epidemic DALY of disease A after spending surpassed a threshold. The harm is exclusively due to a higher DALY burden of unprevented cases of disease B. These cases of B were not prevented because the windfall payments to doctors during an epidemic of disease A were used to lobby the government for a larger share of the fixed health budget. An epidemic of disease A would trigger more fee based revenue for doctors, more NGO based revenue for doctors, and more government based revenue as a rational response. Whereas the NGOs and government were obligated to allocate funds rationally in proportion to the DALY burden, the sick patients, during epidemics of disease A, were not pursuing an optimal societal allocation of revenue to doctors. The patient revenue to doctors helped their lobbying power grow abnormally large. Patient-driven revenue led to so much doctor lobbying power that the prevention budget became squeezed towards zero and the burden of disease B rose. In models where D_A was a lot higher than D_B , the iatrogenic epidemic of disease B could trigger remedial spending by the donor, but government health budgets had limited response to the epidemic due to doctor lobbying. Spending on doctors during the epidemic of disease A leads to doctors' lobbying activity depleting the fixed government allocations to PCWs and leaving the population vulnerable to disease B. Without the agency of PCWs to prevent disease B, people perished in higher numbers. In Figure 7, the model shows negative returns to investment in responding to cures with an inflection point occurring around \$20 per DALY of disease A. Being willing to spend more than \$20 per case of disease A in an epidemic of disease A creates a higher death rate from unprevented cases of disease B.

Our sensitivity analysis, which focused on testing different DALY weights for diseases A and B as well as disruptions in funding to either doctors or PCWs, confirmed the robustness of the phenomenon of negative returns to spending high amounts per case of B. We observed the same findings despite 10% shifts in the DALY weight for either disease and despite 10% shifts in the government's standard response to epidemics, signaling that our conclusions were not simply a product of our initial set of parameters.

Policy analysis explored what happens in a context where doctors lose their ability to earn consultation fees from seeing patients. By removing doctors' disease-driven earning, and therefore making their income symmetrical to PCWs, we saw the backward bending cost-DALYs effects observed in Figure 7 disappear. Another policy analysis removed all lobbying power of both doctors and PCWs. By removing lobbying from our model,

we no longer observed the backward bending effects seen in Figure 7. Either modification was enough to eliminate the damaging effects on population health of spending more money on curative services. Both solutions were effective and the results qualitatively resemble Figure 7 (results available in a supplementary appendix).

Discussion

This system dynamics model of resource allocation explicitly models political influences on the allocation of public spending in the health sector. It illustrates potential unintended consequences from fully rational NGO contributions to respond to epidemics. Considerations from complex adaptive systems guided the exploration of non-linear, unintended consequences in a simulated health system – something that cannot be accomplished using traditional cost-effectiveness analysis techniques. The results offer several cautions about irrational distortions that occur in human systems even when rational policies are pursued. The donors in the simulation were efficiently allocating resources in proportion to the opportunity to avert the most DALYs per dollar, but political lobbying resulted in their allocations to the doctors snowballing into a large political lobbying fund that starved the preventive work of the PCWs and led to higher costs and unnecessary deaths.

It is significant to note that the NGO's response to epidemics of disease A did not factor in the fungibility of private spending on disease A. The NGO was programmed to assume that its donations were not being matched by private sector patient payments. If the NGO had been reducing its donations dollar for dollar in response to private spending, then the tragic loss of life from the crowd out of preventive spending would not have occurred. Traditional cost-effectiveness models have no way to simulate this type of unintended consequence because traditional cost-effectiveness measures costs, but says little about who will ultimately pay the cost. Furthermore, traditional cost-effectiveness cannot accommodate a positive feedback loop in which spending on a particular health resource creates obligations to irrationally escalate spending on that resource due to political pressure from those who prosper from the initial allocation.

Our findings add further insights into the debate on optimal resource allocation between curative and preventive care. Because curative medicine offers services whose benefits are privately enjoyed by each sick person they are defined by economics as "excludable goods". Market mechanisms work well to balance supply of resource flows in proportion to the demand for excludable goods [28]. In contrast, the benefits of community prevention-work are non-excludable; everyone benefits but wants someone else to pay. With no defined property rights to transmit an effective demand signal to

suppliers, the system is prey to failure and maladaptation. The under-investment in community prevention joins a long list of many other market failures in health [28]. Community health advocacy falls to an assorted collection of community advocates, academics, and enlightened spokespersons [29]. In public policy-making it is common to hear advocates declare that their sector is “high priority” and requires special treatment [30]; it can be difficult at times to assess the legitimacy of competing claims. However, the missing market for population-level prevention efforts and their history of extremely large benefits at low cost suggests that this might be an area that is perennially and inappropriately neglected.

Our model’s focus on the asymmetric ability of the doctor class to achieve political clout from billable fees offers a cautionary lesson for NGO donors. When donors compassionately invest in curative strategies they may unwittingly contribute to the rent-seeking capability of the doctors. Health systems can inappropriately de-prioritize prevention efforts delivered at population level. If it were easy to do so, an NGO or donor should stay informed about private revenue streams that could be augmenting their own allocation to address health problems. These private revenue flows can unbalance what could have been a measured response to a health issue, and require the donor to offset its contribution accordingly or focus to sub-populations that were not being covered privately.

Funding for HIV/AIDS treatment programs in low-income countries may be an example where cure is crowding out prevention through a mechanism similar to the one in the model. Countries with limited human resources for health cannot absorb large amounts of donor spending on antiretroviral programs without staff redeploying away from their primary care jobs into the well-funded antiretroviral programs. Evidence of weaker performance on maternal and child health programs where HIV burdens are higher might be suggesting this sort of tradeoff [31,32].

Although we use the word “lobbying”, the basic dynamics observed in the model do not require there to be an organized medical, pharmaceutical, or hospital association with a specific lobbying fund supporting politicians; real-world health care interest lobbies are much more subtle. Health care lobbying can be emotionally appealing and seductive. It is common for motivated disease advocates to spotlight a photo with a victim of a curable disease, or to note how a disease victim’s treatment is a human right [33,34]. Global donors are emphasizing disease-curing funds (e.g., providing AIDS, tuberculosis, and malaria treatments). The drive towards universal health insurance coverage is also an instance of lobbying that serves clinical interests while addressing rights to health care services. The growth of health

insurance can trigger a self-perpetuating feedback loop of political power by those who provide clinical care. One approach to protect prevention would be to ring fence prevention funds. Another approach would allocate donor funds preferentially to the neglected prevention sector as was done during a World Bank loan to Argentina [35]. Both of these approaches face challenges if the government is under high lobbying pressure. The ring fence can be punctured and the aid can be fungibly reallocated unless there is high commitment by the government to preserve a high priority sector [30].

Our model shows that the harmful spiral can be eliminated by eliminating patient fee payments or by eliminating any lobby-type linkage between health worker revenue and government spending. Although these extreme scenarios were modeled, total elimination is impractical in the real world. The reason to focus on patient fees is that it is only the fees that give doctors asymmetric growth in epidemic-driven revenue that is not enjoyed by PCWs. Epidemics of disease A enriched the doctors in payments from both doctors and the government. Epidemics of disease B enriched the PCWs only from government or donor funds because there could be no private market based on preventing disease B. The absence of a functioning market for community prevention efforts requires a central planning function to step into the breach and dial up or down government spending based on epidemiological data and data on total health expenditure. Our paper emphasizes that this central intervention is prone to being captured and manipulated by selfish interest groups and requires institutional measures that insulate it. The National Health Service of the UK offers an example of a policy solution to this dilemma in which public health budgets are “ring-fenced” to prevent clinical enterprises from infringing on them [36].

Our model provides a quantitative application of complex adaptive system methodologies to health care systems and policy analysis [37-40]. It is an illustrative tool which was created to foster insight and understanding of unintended consequences from the financing of curative and prevention care. Preventive community-wide efforts in health labor under several disadvantages. When preventive services need to compete against cure for a common pool of government resources they are likely to suffer. They can be politically outgunned because curative health workers have the ability to amass more money through fees while community prevention workers cannot. A zero-sum game played between prevention and cure is not a fair contest.

Abbreviations

DALYs: Disability-adjusted life years; NGO: Non-governmental organization; PCWs: Preventive care workers.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

DB led the conceptualization and implementation of this activity. DB, LP, and QL developed the final model and analyzes, as well as prepared the first draft of the manuscript. DHP and AAH contributed to revisions and finalizing the manuscript. All authors read and approved the final manuscript.

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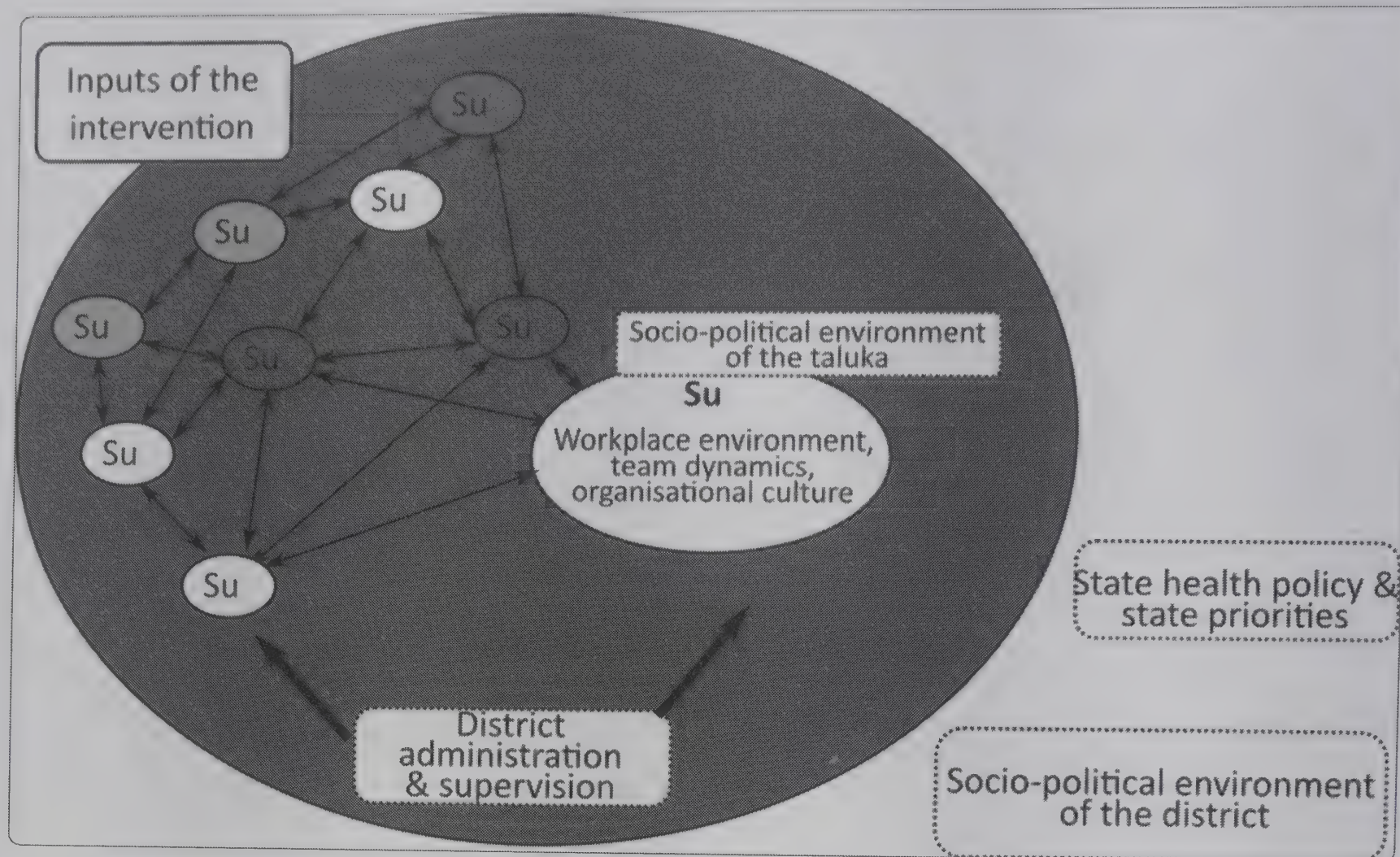
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Advancing the application of systems thinking in health: a realist evaluation of a capacity building programme for district managers in Tumkur, India

Prashanth *et al.*



RESEARCH

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Advancing the application of systems thinking in health: a realist evaluation of a capacity building programme for district managers in Tumkur, India

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Abstract

Background: Health systems interventions, such as capacity-building of health workers, are implemented across districts in order to improve performance of healthcare organisations. However, such interventions often work in some settings and not in others. Local health systems could be visualised as complex adaptive systems that respond variously to inputs of capacity building interventions, depending on their local conditions and several individual, institutional, and environmental factors. We aim at demonstrating how the realist evaluation approach advances complex systems thinking in healthcare evaluation by applying the approach to understand organisational change within local health systems in the Tumkur district of southern India.

Methods: We collected data on several input, process, and outcome measures of performance of the *talukas* (administrative sub-units of the district) and explore the interplay between the individual, institutional, and contextual factors in contributing to the outcomes using qualitative data (interview transcripts and observation notes) and quantitative measures of commitment, self-efficacy, and supervision style.

Results: The *talukas* of Tumkur district responded differently to the intervention. Their responses can be explained by the interactions between several individual, institutional, and environmental factors. In a *taluka* with committed staff and a positive intention to make changes, the intervention worked through aligning with existing opportunities from the decentralisation process to improve performance. However, commitment towards the organisation was neither crucial nor sufficient. Committed staff in two other *talukas* were unable to actualise their intentions to improve organisational performance. In yet another *taluka*, the leadership was able to compensate for the lack of commitment.

Conclusions: Capacity building of local health systems could work through aligning or countering existing relationships between internal (individual and organisational) and external (policy and socio-political environment) attributes of the organisation. At the design and implementation stage, intervention planners need to identify opportunities for such triggering alignments. Local health systems may differ in their internal configuration and hence capacity building programmes need to accommodate possibilities for change through different pathways. By a process of formulating and testing hypotheses, making critical comparisons, discovering empirical patterns, and monitoring their scope and extent, a realist evaluation enables a comprehensive assessment of system-wide change in health systems.

Keywords: Capacity building, District health system, Organisational commitment, Realist evaluation, Self-efficacy, Systems thinking, Programme theory

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Multilingual abstract

Please see Additional files 1 and 2 for translations of the abstract into Kannada and Hindi languages.

Introduction

A capacity-building intervention that targets district health management teams is complex given that its implementation involves various actors with different objectives, roles, and power. Further, the setting in which it intervenes is complex since district health systems are constantly evolving in response to national policies, the local socio-political environment, and internal dynamics within the healthcare institutions [1-3]. Realist evaluation can help to make sense of the complex nature of change that is expected in a scenario such as a district level capacity-building intervention. In this paper, we aim to demonstrate how the realist evaluation approach helps in advancing complex systems thinking in healthcare evaluation. We do this by comparing the outcomes of cases which received a capacity-building intervention for health managers and explore how individual, institutional, and contextual factors interact and contribute to the observed outcomes.

People at the core of health systems

People are at the core of health systems capacity [4]. One of the characteristics of a well-performing health system is a robust human resources management system that ensures the right conditions to achieve and maintain performance of the health workforce, which includes health managers. Health worker performance is closely related to their management capacity, but not limited to capacity alone; performance of health staff is determined by a variety of factors related to motivation, organisational dynamics and culture, and environmental factors including socio-economic and political factors [5-7]. These determinants of performance are constantly changing. From a complex adaptive systems perspective, capacity and performance could be viewed as emergent characteristics of a district health system that has many constantly self-adjusting and inter-dependent components [8].

From a realist perspective, it is not merely the implementation of programmes, but people, who change things. A programme is expected to work through providing new resources to one or more actors (agents) within this system. In response to the new resources introduced into the system by the programme, a change in the actors' behaviour or their interactions with systemic elements could create a new way of doing things and thus result in the programme outcome. This "new way of doing things" is expected to result in better performance and hence better health services. While programmes could be designed to change behaviour of people through

introducing new knowledge, skills, or ideas, we see that in complex adaptive systems, the response of the people and the systems is neither straightforward nor easily predictable.

Building capacity and improving performance

Capacity building programmes are one of the most commonly used strategies to improve performance of health workers, especially in low- and middle-income countries [1]. However, the connection between capacity building and performance is not straightforward; capacity building is described as being multi-dimensional, spanning individual, teams, institutional, and health system dimensions. Experience from action research in several Indian settings has shown that the more we seek strengthening of systemic capacity, the more complex it seems to be and the harder it is to achieve, being rooted in organisational and the prevailing socio-cultural factors, while implementation of new skills and introduction of tools seem to be relatively less time-consuming and rooted in more technical domains [9]. In view of this multi-dimensional nature of health worker capacity (and performance), the implementation of capacity building interventions in district health systems is complex; improved performance may occur in some settings and not in others. Further, the transition from individual capacity to organisational capacity is not straightforward; several organisational factors play a role in realising the individual capacity of health managers. The disparity in results can be due to a variety of factors, including (but not limited to) the context and the actors' perceptions of the intervention and their responses to it, their interactions with each other, their organisation, and their environment.

Complex adaptive systems: implications for programme evaluation

The conceptualisation of district health systems as a complex adaptive system has implications for evaluating healthcare interventions. In this view, districts are sensitive to (dynamic) contextual factors as well as their initial conditions, which accounts for the often differing outcomes of the same policy or programme. On the other hand, policies or programmes may produce similar outcomes through different organisational configurations within the same district [10]. The literature on programme evaluation as well as on complex adaptive systems urges evaluation researchers and practitioners to adopt research designs that allow the consideration of unanticipated effects, adopting more flexible designs, capitalising on patterns and regularities emerging in the observations, and adopting an iterative manner of inquiry [2,11]. Studies that embrace complex adaptive systems thinking and theory-driven methods inherently allow for these aspects as they invariably involve several cycles of

observations and analysis, especially in the complex healthcare settings. In public health, programme evaluation has embraced complexity. The recently revised Medical Research Council guidance for the assessment of complex interventions, for instance, calls for a closer examination of the causal mechanisms and theory-building to contribute to developing more effective interventions, and provide insight into how findings might be transferred across settings and populations [12,13]. However, flexible research designs for understanding change in response to interventions in a complex adaptive system may have trade-offs in terms of generating knowledge that has external validity beyond the intervention being studied. In this paper, we present a case for using realist evaluation (explained below) to explain change within complex adaptive systems such as a district health system, while broadening the transferability of results [14].

Realist evaluation and complexity

The realist evaluation approach engages with complexity by taking an open systems approach to social systems [15]. The number of interacting agents, components, and forces that influence people and organisations in a given system is high, outcomes are sensitive to initial conditions, and thus outcomes are likely to show high variability. The realist approach to this complexity is to view reality as being stratified, with several layers of explanations to be found for the empirical observations. This provides a possibility to hypothesise and refine our explanations of why some phenomena occur [15,16]. In the realist view, there are many possible behavioural choices that people manifest (or not) in specific conditions, which results in the outcome. An evaluation using the realist approach thus begins by seeking an explanation for why the outcome of interest occurs in some places and not in others, keeping in mind that programmes work through people and their choices. Programmes facilitate agents to make choices and interact in new ways by providing physical or symbolic resources [17].

In order to understand the relationship between intervention, context, and outcome, realists use the concept of mechanisms, which are the “... *underlying entities, processes, or [social] structures which operate in particular contexts to generate outcomes of interest*” [16]. In the case of complex adaptive systems, several latent mechanisms could be present within the system, which can be triggered by the intervention in the presence of specific contextual elements and result in the observed outcomes [18]. In practice, realists use the context-mechanism-outcome (CMO) relationship as a tool for empirical investigation and analysis. It allows for developing an explanatory theory of why the intervention worked for

some and did not for others (Figure 1). Theoretical explanations of this kind are referred to as middle-range theories, explanations which “...*involve abstraction... but [are] close enough to observed data to be incorporated in propositions that permit empirical testing*” [16,19]. It should be noted that in the literature, middle range theory and programme theory are increasingly used interchangeably. In this paper, for reasons of clarity, we will use the term programme theory.

In a realist approach, the evaluation begins with formulating a programme theory (integrating the assumptions of the programme designers and implementers with the existing wider knowledge or evidence on the topic and insight regarding the contextual factors that could affect the outcome). The programme theory is tested through empirical studies and a refined theory that explains why the intervention worked for some and not for others is the end point of the evaluation. This could be the starting point for a next study. Such cycles allow for fine-tuning of the programme theory and ultimately to accumulation of insight.

The seeking of an explanation for the patterns (or demi-regularities, which are somewhat predictable patterns or pathways of programme functioning) seen in some cases (and not in others) is the hallmark of a realist evaluation [14,21,22]. This addresses one of the features of complexity in social systems, wherein orderly patterns could be seen at the systems level, but often not at the individual level, due to reiterative positive and negative feedback loops among some components (and not in others) [23]. The foundations of realist evaluation within critical realism^a, and its evolution as a scientific evaluation method are described by Pawson [14]. Its potential as an evaluation approach for complex health systems problems has gained interest over the last decade [24-28].

In this paper, we use a case study approach to explore how a capacity building intervention implemented in two different places in a district (both nested systems within the larger complex system of the district) evolved over time, using a realist evaluation, in order to understand how and why observed outcomes occurred. In line with the realist evaluation approach, cases were purposively selected to allow testing of the programme theory propositions and to improve our understanding of why programmes work for some and not for others [15]. We then use the multipolar framework to summarise how the capacity-building intervention could have led to organisational change in a district health system. The multipolar framework, inspired by Champ et al. [29], is a heuristic tool that has been used to explain organisational change in healthcare organisations in high-income settings with recent application in low- and middle-income country settings [22,30].

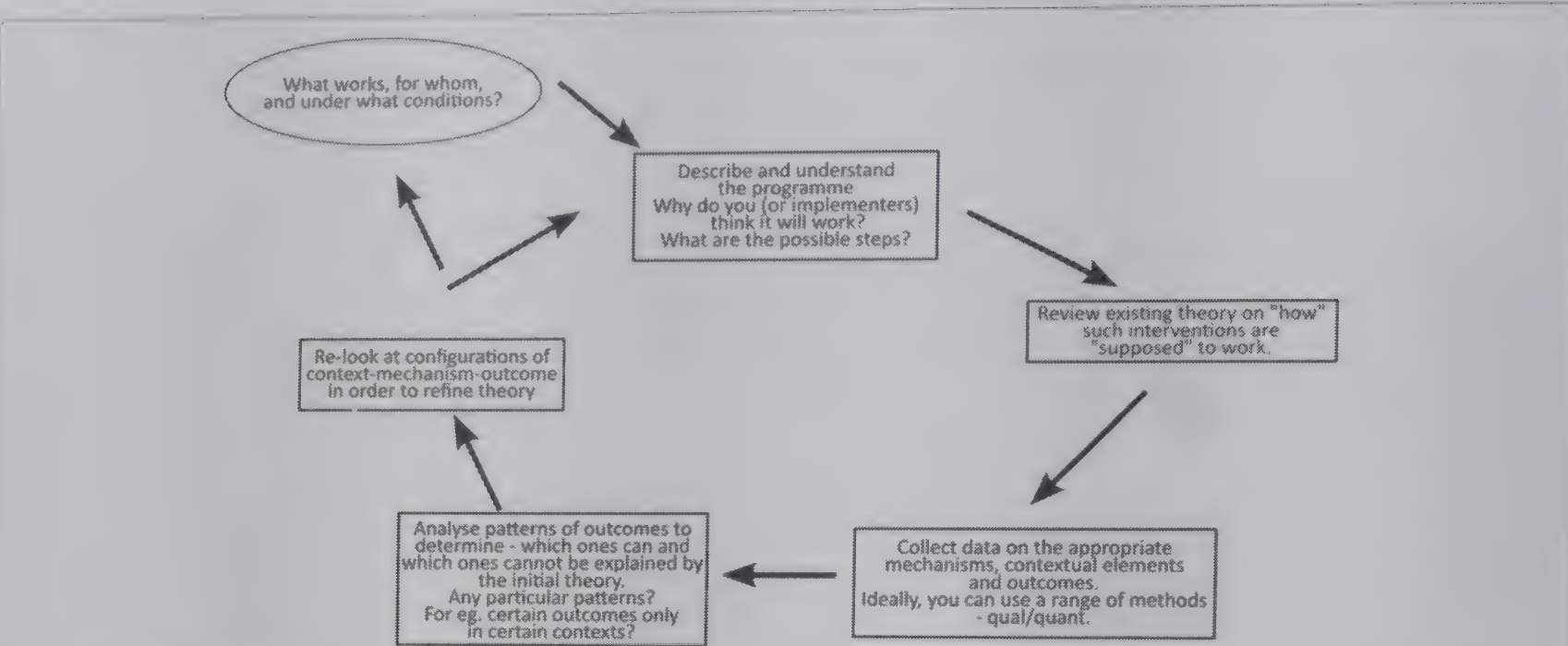


Figure 1 The realist evaluation cycle showing the steps in a realist evaluation study. Figure based on steps described by Pawson and Tilley [20].

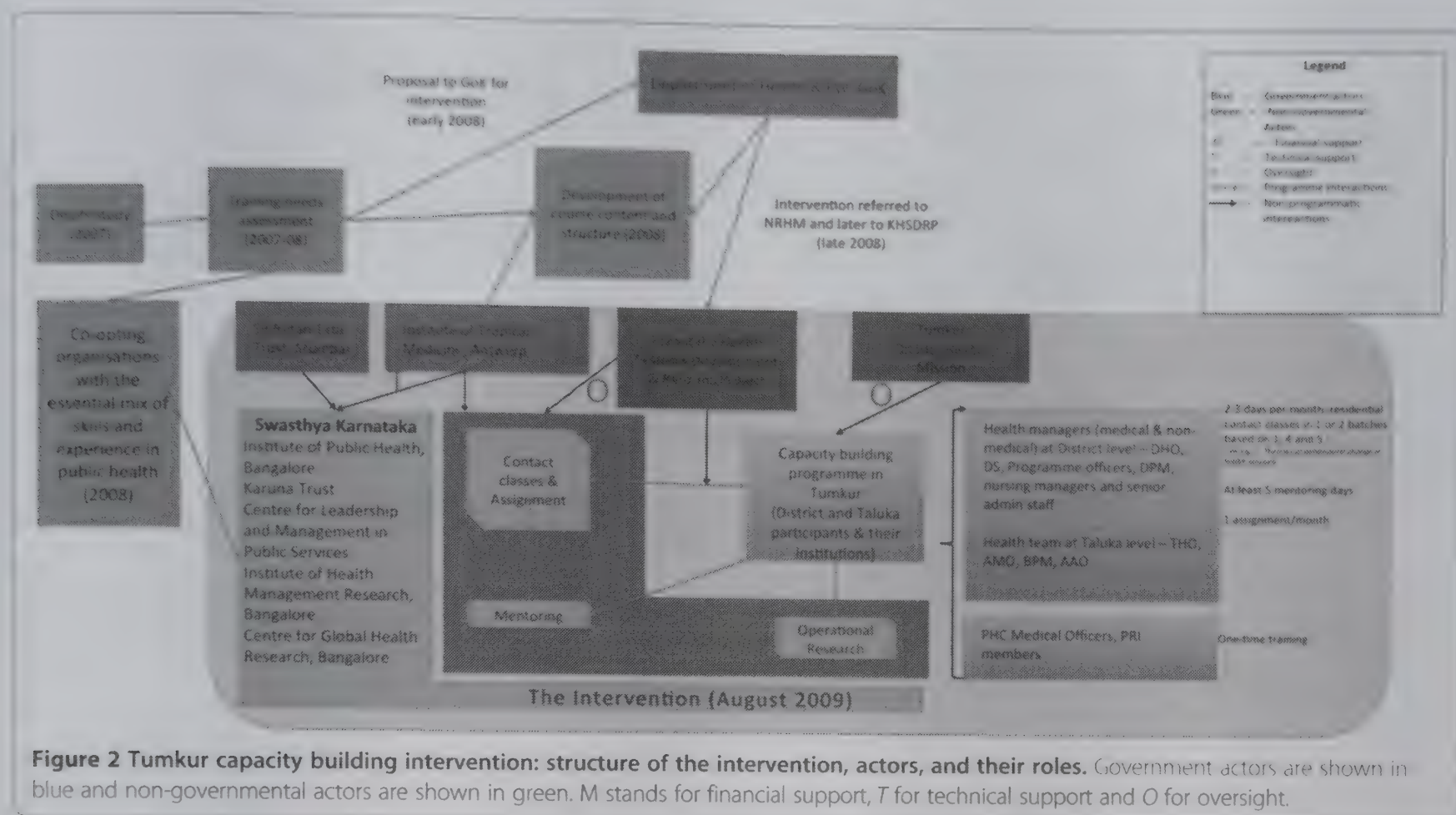
Study setting

This study is based on a capacity building intervention in Tumkur district, which is one of the 30 districts in Karnataka state in southern India; Tumkur had a population of 2.67 million in 2011 [31]. It is an average district with respect to health and development indicators; it ranked 15th in the human development index ranking of the (then) 27 districts of Karnataka in 2005 [32]. In Karnataka, poor health outcomes in maternal health have been attributed to systemic failures in managing health services and responding to critical problems service delivery [33]. Karnataka, like many other Indian states, lacks a management cadre within the health services. In Tumkur, as in all the other districts of the state, doctors with specialisation in one of the clinical specialities and several decades of experience in hospital settings are appointed as health managers of districts and sub-districts without formal or in-service management training [34-37].

The district health system in Karnataka is composed of several sub-systems called *talukas*. They are the political and administrative sub-units of the districts. In 2011, the *taluka* population in Tumkur district ranged from 168,039 in Koratagere to 598,577 in the Tumkur *taluka*. *Taluka* health management teams are under the charge of a *Taluka* health officer (THO). An administrative medical officer (AMO) is in charge of the hospital, while the THO has the operational responsibility for the Primary Health Centres (PHC). The THO, AMO, and other members of the *taluka* health management team hold monthly review meetings of the *taluka* in which the block programme managers^b and senior nursing staff participate.

A consortium of five non-governmental organisations partnered with the state government to organise a capacity building programme for health managers of Tumkur district. The programme consisted of periodic contact classes spread over 18 months (August 2009 to January 2011), periodic mentoring visits to participants' workplace (till December 2011), and assignments to help participants apply the knowledge and skills discussed in the classroom teaching. The aim was to bring about organisational change at the district level through improving the performance of health managers with respect to planning and supervision of health services. The intervention identified capacitated health managers as the agency through which organisational improvement could be achieved. People were seen as being at the centre of organisational change. A much shorter intervention, consisting of a one-time five-day of contact classes for all the 162 medical officers of the primary health centres of Tumkur district (all supervised by the health managers trained under the main intervention) and a facilitated discussion with *Panchayati Raj Institution* representatives (PRI), was also conducted. PRI representatives are members of the elected bodies of the local governments at village and sub-district levels. The components of the intervention and the various actors involved are shown in Figure 2. A detailed description of the intervention and its implementation has been presented elsewhere [38,39].

In this paper, our purpose is to describe the complexity of a capacity-building intervention at the district level and illustrate the utility of the realist approach in advancing the practice of systems thinking in complex settings.



Methods

The realist cycle

A realist evaluation begins with developing the initial theory. A programme theory is best considered as an explanatory pathway, connecting the inputs of the intervention to the expected outcomes, taking into account possible contextual factors and mechanisms [40]. The refining of the programme theory, starting from the initial programme logic of the designers, to a refined programme theory incorporating insight from literature, design of the programme, and its implementation context, is explained elsewhere [41]. Our refined programme theory was aimed at explaining the differences in *taluka* outputs following the intervention, accounting for differences in the individual characteristics of the health managers, institutional factors within the two *taluka* health services and the differing environmental factors. The refined programme theory of the intervention that guided the choice of data and the analysis is shown in Figure 3.

Case selection

In the second step, cases were selected purposively. We assessed the performance of the 10 *talukas* of Tumkur district from 2009 to 2012, focusing on performance aspects that could be logically connected to the capacity building intervention (using the programme theory of the intervention as a guide). We scanned *taluka* performance with a focus on those showing least and most improvement; we chose one positive and one negative outlier (contrasting case selection) for the analysis presented in

this paper. Figure 4 shows the *talukas* of Tumkur, including the *taluka* hospital and the PHCs.

Data collection

In realist evaluation, the choice of data to be collected is guided by the programme theory. First, we collected data on the intensity of the programme implementation: participation in classroom activities, frequency of mentoring visits, and retention of mentoring interest. The mentors seem to have preferred *talukas* based on their own assessment of interest shown for mentoring by the *taluka* team. Hence, retention of mentor interest has been chosen as a proxy for the *taluka*'s commitment towards the vision for change as articulated by the intervention. It was assessed on the basis of frequency of mentoring visits and observation notes of the mentors, and scored into high, moderate, and low. Second, we assessed intermediate outputs (self-efficacy, organisational commitment, style of supervision, and expression of intention of *taluka* managers to make changes) using data from a survey of health managers in Tumkur.

Organisational commitment along with self-efficacy has been described as being crucial to performance and is considered as a key mechanism explaining human agency in various settings [42,43]. The three-component construct of organisational commitment by Meyer and Allen describes the nature of commitment of people to their organisations along three dimensions: affective commitment (emotional attachment to the organisation; a feeling of belongingness), normative commitment (a feeling of

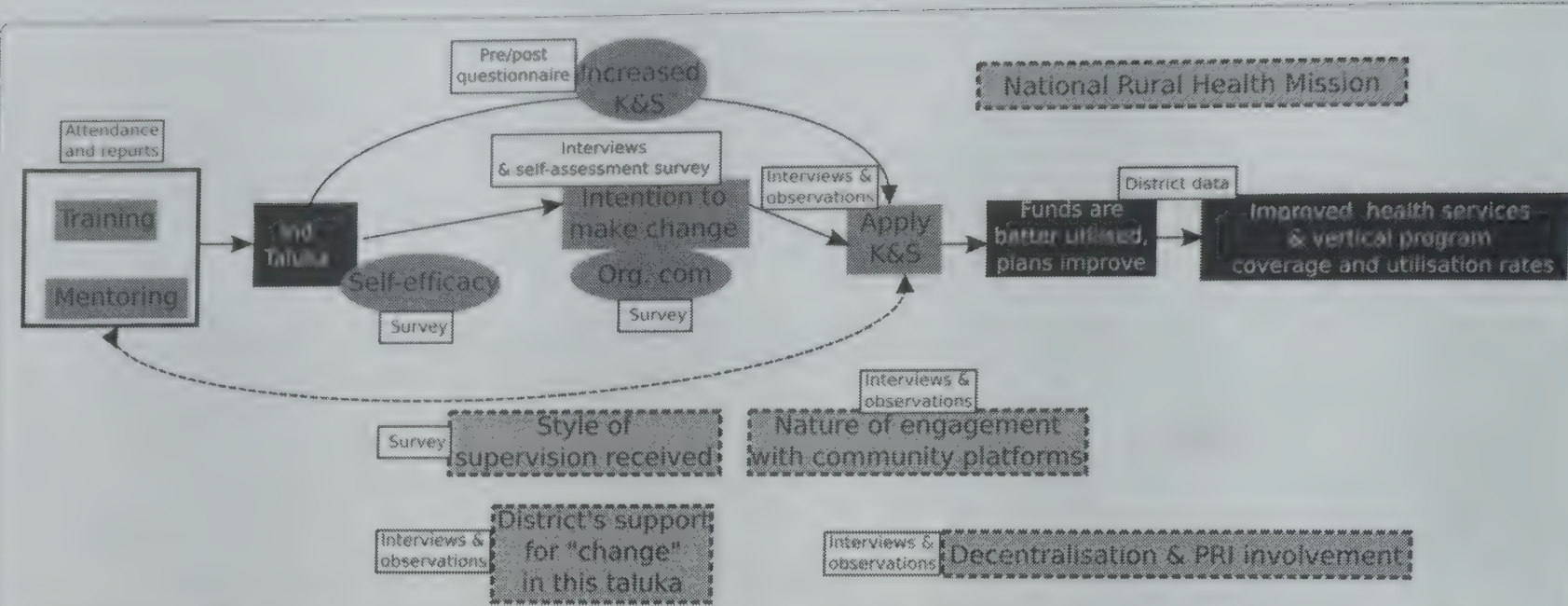


Figure 3 The refined programme theory of the intervention showing possible intermediate steps between intervention inputs and expected outcomes. Data collected for the intermediate steps are shown. Grey boxes with stippled border show contextual elements identified as having an influence on the intervention outcomes during the refining of the programme theory. Unshaded boxes indicate the source of data. Boxes shaded black indicate outcomes. Intermediate steps are shown in boxes shaded grey with no border.

being obliged to the organisation), and continuance commitment (a feeling of being in the organisation because of a lack of alternatives) [44]; the three different dimensions of commitment co-occur. Self-efficacy was measured using a 10-item scale based on the Bandura scale [45] and degree of supportive nature of supervision was measured using a Likert scale questionnaire adapted from a tool by Oldham and Cummings and the Michigan Organizational Assessment Package [46,47]. The tools used have been described earlier and published elsewhere [39].

To assess the distal outputs of the intervention, we collected annualised data on budget utilisation, provision of 24/7 PHC services, coverage rates of institutional delivery, delivery by caesarean section (CS), completion of three antenatal care visits, and immunisation. We also assessed changes in infant mortality rate and stillbirth rate from 2008 to 2012. Stillbirths and infant mortality reported in all the facilities of the *taluka* were used to calculate the rates. These quantitative data were supplemented with qualitative data collected through interviews with health managers and observations. In-depth interviews were conducted with 21 health managers of Tumkur who participated in the intervention, their superiors at state level ($n = 2$), and their subordinates (PHC health staff and co-workers; $n = 4$). Participant observation of monthly and annual review meetings at the *taluka* and district level was carried out to understand the organisational dynamics and the differences in interpretation and implementation of state policy.

Analysis

All interviews were transcribed and entered into NVivo 10 (QSR International Ltd., Australia), together with the

observation notes. During the analysis, we used the CMO as a heuristic tool (Table 1). These hypothetical CMO frames were based on the refined programme theory of the intervention, as described elsewhere [41]. Initial codes reflected the programme theory elements of intervention, actors, context, mechanism, and outcomes, and new codes emerged. The quantitative data, including measurements of organisational commitment, self-efficacy, and style of supervision provided were integrated into the analysis and this helped in triangulating emerging findings. In this way, each case was analysed.

We then compared the two *talukas* to further test whether the refined programme theory explained the differences in the outcomes. We supplemented these two contrasting case studies with demi-regularities from comparable settings in the other *talukas*. We focused on the internal dynamics within the *taluka* teams (micro-context) and the interaction of these teams with the immediate *taluka* environment (meso-context) and the larger policy environment at the district, state, and above (macro-context). We also described the organisational configurations of the two cases using the multipolar framework.

Results
Outcomes

The responses of the *talukas* to the intervention varied, as shown in Table 2. The aggregated budget utilisation rate for Tumkur district^c increased marginally, from 83% in 2009 to 85% in 2012. However, this conceals a variety of responses at *taluka* level. In Figure 5, the net annual change in utilisation (the net change in the proportion of available funds timely spent between two years)



Table 1 Identifying context-mechanism-outcome frames based on the programme theory of the intervention

Programme inputs (IPT) and how they were supposed to work	Key assumptions identified during the refining of IPT	Supporting theory	Key contextual factor (C)	Outcome of interest (O)	Plausible mechanism (M)
Contact classes work through improving knowledge and/or skills, resulting in improved performance	An attitudinal change among the participants is needed to achieve the desired results	Outcomes of training programmes accrue through four hierarchical levels: reaction (to training programme), learning, behaviour, and impact [48]	Team dynamics affect the individual's intention for positive change Socio-political environment in the taluka/district	Intention to make positive changes	Motivation of the participant towards positive organisational change – a “can-do” attitude
Mentoring participants at workplace facilitates application of knowledge and skills	Targeting individuals will produce impact through teams	Workplace environment in healthcare organisations has been identified as an important element explaining application of learning from training programmes [49]	Nature of supervision and district's openness to “allow” change Decentralised action plans and decision-making at district and lower levels. State and higher levels' openness to change proposals	Identify/seek opportunities to make positive change in the organisation's performance Improved annual action plans – better situation analysis, problem identification, allocation and utilisation of resources	Nature of commitment to organisation Self-efficacy
A capacitated health manager can become an agent of positive organisational change	Capacity leads to performance The programme could benefit from alignment with existing policy initiatives	High commitment management literature shows the potential for change by committed staff in settings where resources could be mobilised [50]	Change proposals by districts are in line with state (or central) vision and address local needs (allocation and strategic alignment with external environment per Champ et al.'s conceptual framework) [29]	Taluka and district plans improve. They identify more needs, mobilise more resources from state, and utilise them better	Claiming and utilising decision spaces; organisational commitment and self-efficacy in negotiating with superiors and community leaders

Table 2 Assessment of exposure to intervention, key intermediate mechanisms (commitment and efficacy), and outcomes of the 10 talukas of Tumkur

	Classroom participation ¹	Mentoring ²	Retention of mentoring ³	Organizational commitment ⁴	Self-efficacy ⁵	Supportive supervision ⁶	Intention to change ⁷	Stability of team ⁸	Net change in budget utilisation ⁹	Net change in CS rate ¹⁰	Net change in stillbirth rate ¹¹	Development index ¹²
	0.7	0.7	High	AC 2.66 NC 2.47 CC 2.42	68	2.5	50	Moderate	2	1	-16	0.95
Tumkur	0.7	0.7	Moderate	AC 2.85 NC 2.46 CC 2.69	68	2.6	75	Low	6	1.5	-8	1.21
CN Halli	0.6	0.5	Moderate	AC 2.75 NC 2.29 CC 2.71	70	2.2	100	High	4	0.1	0	1.02
Turuvekere	0.6	0.4	Low	AC 2.81 NC 2.80 CC 2.47	68	2.4	83	High	5	5.8	-4	1.06
Tiptur	0.5	0.5	Moderate	AC 2.25 NC 2.33 CC 3.17	86	2.5	75	Low	-4	12.6	-1	1.25
Koratagere	0.4	0.5	Low	AC 2.87 NC 2.73 CC 3.07	71	2.3	20	Moderate	3	1.8	-3	0.89
Madhugiri	0.5	0.5	Low	AC 2.50 NC 2.03 CC 2.50	83	2.4	40	High	4	1.3	-1	0.82
Pavagada	0.6	0.5	Moderate	AC 2.50 NC 2.05 CC 2.28	79	2.3	0	High	6	0	1	0.78
Kunigal	0.6	0.5	High	AC 2.12 NC 2.59 CC 2.83	83	2.2	75	Moderate	2	4.9	-4	0.96

Table 2 Assessment of exposure to intervention, key intermediate mechanisms (commitment and efficacy), and outcomes of the 10 talukas of Tumkur (Continued)

Sıra	0.7	0.9	High	AC 1.80	68	2.2	100	Moderate	6	8.3	2	0.8*
				NC 2.00								
				CC 2.67								

¹ Average of degree of classroom participation of all participants from a taluka, based on assessment of attendance and classroom activity (assessed by observation notes) expressed on a scale of 0 to 1.
² Average of degree of mentoring received based on attendance of participants at mentoring sessions (0 to 1.0).
³ Qualitative assessment of the taluka's ability to retain interest of the mentor expressed as high, moderate, and low.
⁴ Three dimensions of organisational commitment: Affective commitment (AC), normative commitment (NC), and continuance commitment (CC). Individual commitment measures for each of these three dimensions were computed and the averages of these were calculated by taluka. Commitment scores are on a scale of 0 to 5.
⁵ Self-efficacy scores expressed on a scale of 0 to 100.
⁶ Style of supervision largely assessing supportive nature of supervision (1 to 5; 1 being most supportive and 5 being most authoritative).
⁷ Percentage of ever-trained members in the taluka, who expressed intention to make changes based on the capacity building programme.
⁸ Stability of team assessed based on turnover of health managers in the taluka team from 2009 to 2013 expressed as high, moderate, and low. High indicates stable teams (low turnover).
⁹ The net change in percentage budget utilization from 2009 to 2012. Budget utilisation for each of the PHCs in the taluka was obtained.
¹⁰ The net change in proportion of caesarean sections (CS) among total deliveries from 2009 to 2012. CS at taluka hospitals is at present very low and efforts are on to improve emergency obstetric care at taluka hospitals through ensuring facilities to perform CS.
¹¹ The net change in stillbirth rate (of the total live births in the taluka) from 2009 to 2012. Negative change indicates a fall in stillbirth rate.
¹² The socio-economic development index for the taluka. Scores less than 1 are considered very poor and such talukas have been designated "backward" [51].
The tools for measuring organizational commitment, self-efficacy, and supportive supervision notes on their validity in Indian settings are discussed elsewhere [39].



Figure 5 Annual change in utilization rate of selected *talukas* of Tumkur district from 2010 to 2012. The net change (from the previous year) in the aggregate budget utilization rates of all facilities in the *talukas* are shown for CN Halli, Tumkur, Sira, Gubbi, and Madhugiri *talukas*. The District figures are for utilization rates of budget allocated for disease control programmes and other functions managed at the district level.

from 2010 to 2012, is shown. While some *talukas*, like Pavagada, improved their utilisation rate, others, like Madhugiri, reduced their spending rates. Yet others, like Turuvekere, showed wide changes from one year to another, while net change from 2012 to 2009 was only marginal.

In Figure 6, the stillbirth rate in 2012 is plotted by *taluka*, against net change in stillbirth rate from 2009 to 2012. We use the net change in stillbirth rates as a proxy indicator of performance. Stillbirth was chosen because of the emphasis in the intervention on using planning (through good annual situation analyses and problem

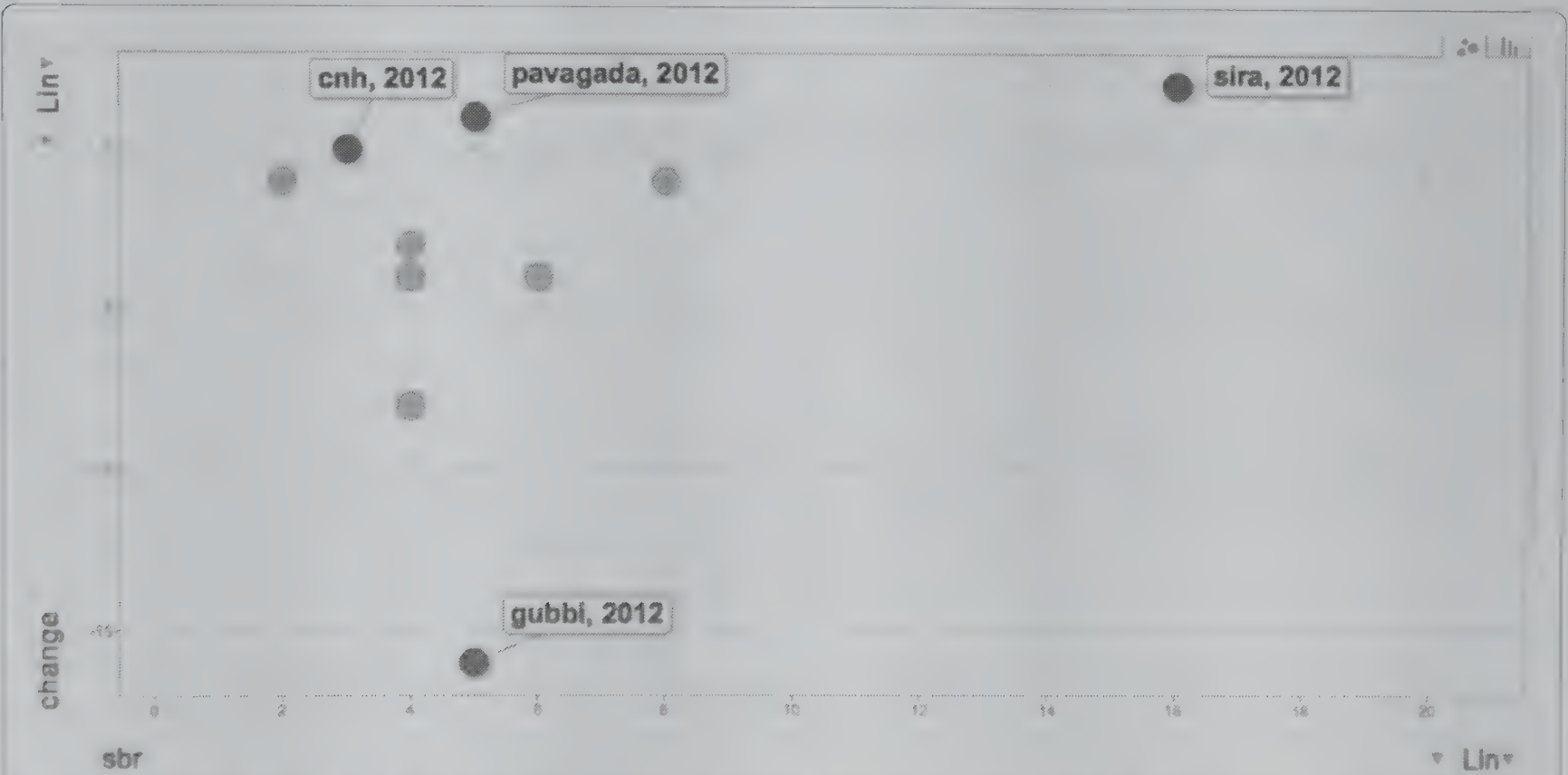


Figure 6 Stillbirth rates in 2012 by *taluka* shown against net change in this indicator from 2009 to 2012. Gubbi, Sira, Pavagada, and CN Halli stillbirth rates are labelled.

identification) and supportive supervision in improving maternal and child health outcomes. Such variability could result from several factors, including existing reform processes that promote institutional deliveries, and improvements in the functioning of the health services (including the capacity building intervention). Besides such interventions, which influence all *talukas* to the same degree, context-specific socio-political factors and organisational factors, which are of interest in our evaluation lie, within the *taluka* health services and could influence performance. We shall use the variability in the *taluka* level outcomes to purposively choose *talukas* and examine if the hypothesised explanations from the refined programme theory could explain these differences.

In Table 2, the various individual, team, and institutional factors that we assessed based on the programme theory are shown. The factors chosen are a mix of individual and organisational contextual factors (intervention exposure, socio-economic development index of *taluka*, mentoring interest and supervision received, and team stability), mechanisms of human agency at the individual level (intention to change, organisational commitment, and self-efficacy), and proxy measures of outcomes logically related to improvements in the *talukas* expected from the intervention as well as more distant *taluka* outcomes determined by several other factors. The *talukas* varied in their participation in classroom and mentoring activities, in view of transfer in and out of health managers in the *taluka* or absenteeism (either by choice or due to priority work at the *taluka*). Higher participation in the intervention did not always result in an intention to make changes at the workplace (e.g., Gubbi and Tumkur with highest participation and only moderate expressions of intention for positive change); nor did expressions of such intentions always result in improved outcomes (e.g., CN Halli with a 100% of the team expressing intent but showing negligible change over the three years in the outcomes).

We purposively present the summary of the analysis of two contrasting cases – Gubbi and CN Halli – among the 10 *talukas* to illustrate how the CMO lens derived from our refined programme theory can be used to understand and explain how the outcomes in these cases could have come about and what could be the possible contribution of the intervention in these outcomes. We present the summary of the analysis of the empirical data in the form of observed outcome (O) in relation to mechanisms (M) and contextual conditions (C).

Gubbi

Gubbi's stillbirth rate decreased the most among all the *talukas* in Tumkur; the improvements in proportion of CS performed and budget utilisation were modest (Table 2). Health managers from Gubbi participated actively in the

intervention and retained the mentors' interest. They showed relatively higher affective commitment than many other *talukas* (Figure 7). Only half of the health managers expressed an intention to make changes.

From the interviews and observations at Gubbi, the main theme emerging was commitment. The interest shown by the THO and the AMO towards improving services is evident from the interviews. The THO was given temporary charge of heading the team while simultaneously being the medical officer of a nearby PHC. Yet, he felt that he could mobilise greater support to improve services in the *taluka* by motivating like-minded people. He felt that being a health manager is an opportunity to bring about changes.

"In my taluka for example, I think we can make big change. It is not that everybody in my taluka wants to make changes. Only one-third of them are motivated to make changes. And that is enough. I think I can make a lot of improvement by motivating these people."

– *Taluka* health manager from Gubbi (g1)

Such positive assessment of motivation of PHC staff as a strategy towards improving services was not shared widely in the other *talukas*.

Both the AMO and the THO saw the intervention as an opportunity to benefit from the recent efforts to decentralise the preparation of action plans to *taluka* and PHC level. They felt that the decentralisation of planning under the National Rural Health Mission (NRHM)^d was an opportunity to address specific problems at the PHCs.

"More resources mean more opportunities to make change. If they slowly give more and more power to us at taluka level, we can make many more improvements. Right now, very little is possible at taluka level."

– *Taluka* health manager from Gubbi (g2)

"NRHM has given block programme managers. This will improve plan preparation and monitoring. They are young and enthusiastic, but they need to some guidance and I think I can provide that."

– *Taluka* health manager from Gubbi (g1)

This general pattern of commitment at Gubbi is also seen in the Tumkur *taluka*, with a relatively high affective commitment, albeit with a higher turnover of staff.

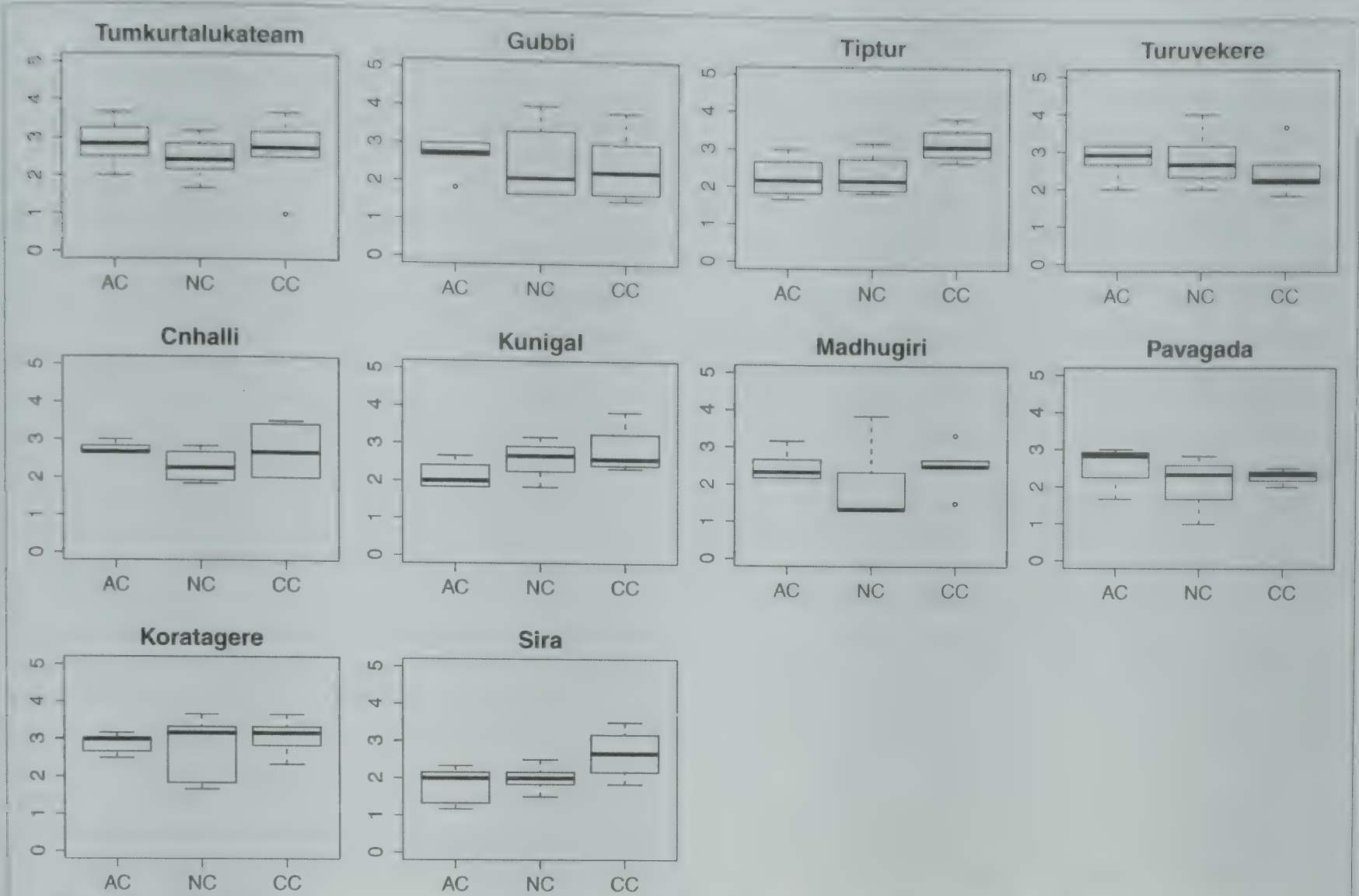


Figure 7 Boxplots of three dimensions of organisational commitment in the 10 talukas of Tumkur district. The three dimensions of commitment are based on Meyer and Allen [44]. AC is affective commitment, NC is normative commitment, and CC is continuance commitment. Individual commitment measures for health managers were computed separately for AC, NC, and CC. For each taluka, box plots of the scores for each of these were plotted.

The Gubbi pattern could be summarised as follows: in a decentralised taluka health system, committed health managers can make use of their increased management capacity to identify opportunities for improving their health services performance.

Chikkanayakanahalli (CN Halli)

While Gubbi is situated close to the district headquarter town of Tumkur, CN Halli is further away, but with a similar level of socio-economic development (Table 2). CN Halli showed hardly any change in most outcomes, in spite of a high intention among the health managers to make improvements in the taluka. CN Halli also had lower turnover rates of taluka level health managers. The level of affective commitment was comparable to that at Gubbi, but continuance commitment was relatively higher.

CN Halli is amongst the most remote talukas. With a limited private sector, it is not a favoured choice of posting for doctors. For several months, the function of THO and AMO was taken up by the same person. The taluka level staff showed commitment towards the services and took

pride in working in a remote taluka with very limited human resources. However, during discussions about decentralised planning expressed by this taluka’s health managers, the dominant theme was frustration.

“What PIP? What decentralisation? I sent so many requirements for staff and proposals for improvement. Only thing I got is more work, less staff and zero solutions. On one hand, I have to answer the local ZP members’ complaints and on the other hand, I have to just keep implementing plans and schemes coming from above. Nothing can be done without more staff.”

– Health manager from CN Halli (cnh1)

While the decentralised planning brought about by NRHM was perceived as an opportunity in Gubbi, in CN Halli the respondents expressed frustration. This was also evident in several meetings at the taluka level, where a lack of power to make changes at the taluka and district level, for instance in recruitment of human resources and purchase of critical equipment, was often raised.

"NRHM has just brought more and more responsibilities, but no powers. For everything, we have to wait for a visit from the secretary or commissioner. More money means more work and more statements of expenditure and paperwork."

– PHC health worker from CN Halli taluka at a review meeting (cnh2)

Similar frustrations about increased paperwork and responsibilities were found in the thematic analysis of interviews and observation notes from Pavagada, another poorly staffed, and the most remote taluka in Tumkur.

"The increased money with NRHM is good. But it's not merely money. We need committed people who can stay in such a remote area. I am from this area and I live and work here. People who come here hardly stay beyond a few months. They either get frustrated or seek transfers."

– Health manager from Pavagada (P1)

The recent reforms towards giving greater powers to the elected representatives were seen as a threat to their functioning. The taluka health staff felt that channelling the frustrations of the PHC staff upwards was their role much more than managing conflicts and frustrations or building amicable relationships with the elected representatives.

"Nothing much can be done without giving powers at taluka level and PHCs. I cannot even appoint a Group D staff. Where is decentralisation in this?"

– a PHC staff from CN Halli taluka

"What more can I do? I communicate promptly to my superior all the problems and I am still waiting for the solutions. In the [capacity building] programme they are saying, find local solutions. With so little staff, how much local solutions can I find? People just don't want to work here. I handle two responsibilities at the same time..."

– Health manager from CN Halli (cnh1)

The pattern of CN Halli is also seen at the Pavagada taluka, which is also severely under-staffed, with a small group of health managers with comparatively lower levels of affective commitment. The improvements of the Pavagada taluka were poor, in contrast to the Sira taluka, which is also geographically remote and socio-economically poor, yet showing a remarkable vision in

the taluka team to operationalize emergency obstetric facilities in the hospital, a dire need in this remote region. The Sira taluka, unlike Pavagada and CN Halli, was much more dominated by a continuance commitment rather than affective commitment.

"We felt that we have to do it. So many mothers were just being referred to Tumkur. The delivery load is high and for several months, we had only one obstetrician, but somehow we managed. I know how the pressure is at the district hospital, so having LSCS facility at Sira decreases the burden at the district hospital. It's not easy, but somehow it is happening."

– Sira health manager (s1)

The pattern of CN Halli could be summarised as follows: Health managers working in poorly resourced talukas, in spite of their improved management capacities and intentions to make change, get frustrated by the lack of facilitating action from above.

Discussion

Health system interventions need to take into account the subunits of the local health system in which they intervene. In this case, each taluka can be conceived as a sub-system with a particular organisational context but a similar macro-context, exposed to the same intervention. In such cases, the realist evaluation approach helps to formulate specific CMO-based propositions that can be tested through comparing contrasting cases. This allows for building explanations on how organisational change occurred in some settings and not in others. The process of testing and refining the CMOs allows for an understanding of the conditions through which such interventions could work in a complex local health system.

Explaining change: contribution of the intervention

While the training programme (the intervention) included all health managers in the district, their actual participation was variable. This depended on several factors at the level of the participant (their interest and motivation), distance between the taluka and the district headquarters, the staff turnover rate, and the responsiveness of the implementers to the taluka teams. Many of these factors are related to each other, sometimes counterintuitively. For example, remote talukas like CN Halli and Pavagada had a relatively low turnover, while more sought-after talukas like Tiptur and Tumkur taluka had a higher turnover. Capacity building interventions that seek to strengthen local health systems ought to take into account such existing variations within the sub-systems at the design stage.

Health system strengthening interventions seek to strengthen core systemic functions of the local health system. The capacity building intervention sought to improve performance through improving planning and supervision. The contribution of such improvement (if any) ought to be framed against several other activities at the PHC, *taluka*, and district levels. For example, the provision of secondary level obstetric care at the *taluka* hospital includes developing the capacity of the facility to conduct CSs; this has been the policy focus in Karnataka for several years. In addition to the state government's pressure to implement this, health managers also face the pressure of the community and local elected representatives to operationalize CS facilities at *taluka* hospitals. However, in spite of favourable environmental conditions at the *taluka* level, effectively ensuring this requires a strong managerial vision and leadership; this was observed only in some *talukas*. This illustrates that, in a district health system influenced by several policies and environmental factors, it may be difficult to disentangle the contribution of the intervention to the observed outcomes. However, by choosing intermediate and distal outcomes at various levels (individual and institutional) that are most sensitive to the intervention inputs, it is possible to identify *talukas* where the intervention could have contributed to the outcome by seeking alignments with existing conditions and the characteristics of the people and teams in these *talukas*.

Capacity-building interventions could work through identifying such existing alignments between local actors' needs, policy, and practice, and by strengthening conditions for the same. As the CN Halli case shows, in spite of favourable policy, community pressure, and a committed team at CN Halli, the frustrations of health managers resulting from previous negative experience with decentralised planning altered their choices and collective agenda-setting against actualising CSs in their hospital. In contrast, health managers of Sira *taluka* showed relatively low levels of affective commitment and self-efficacy, but frustration was low. With the participation of elected representatives and through effective leadership by the AMO, the CS facility was organised. Thus, in a *taluka* considered to be poorer than CN Halli in terms of socio-economic development indicators, the proportion of deliveries conducted by CS increased by 8.3% between 2009 and 2012. Further thematic analysis of *talukas* that resemble some of the characteristics of our cases (such as the case of Pavagada discussed under the CN Halli case summary above) or are contrasting with our cases in some respects, could strengthen our findings and allow validation of these findings in future studies in similar settings.

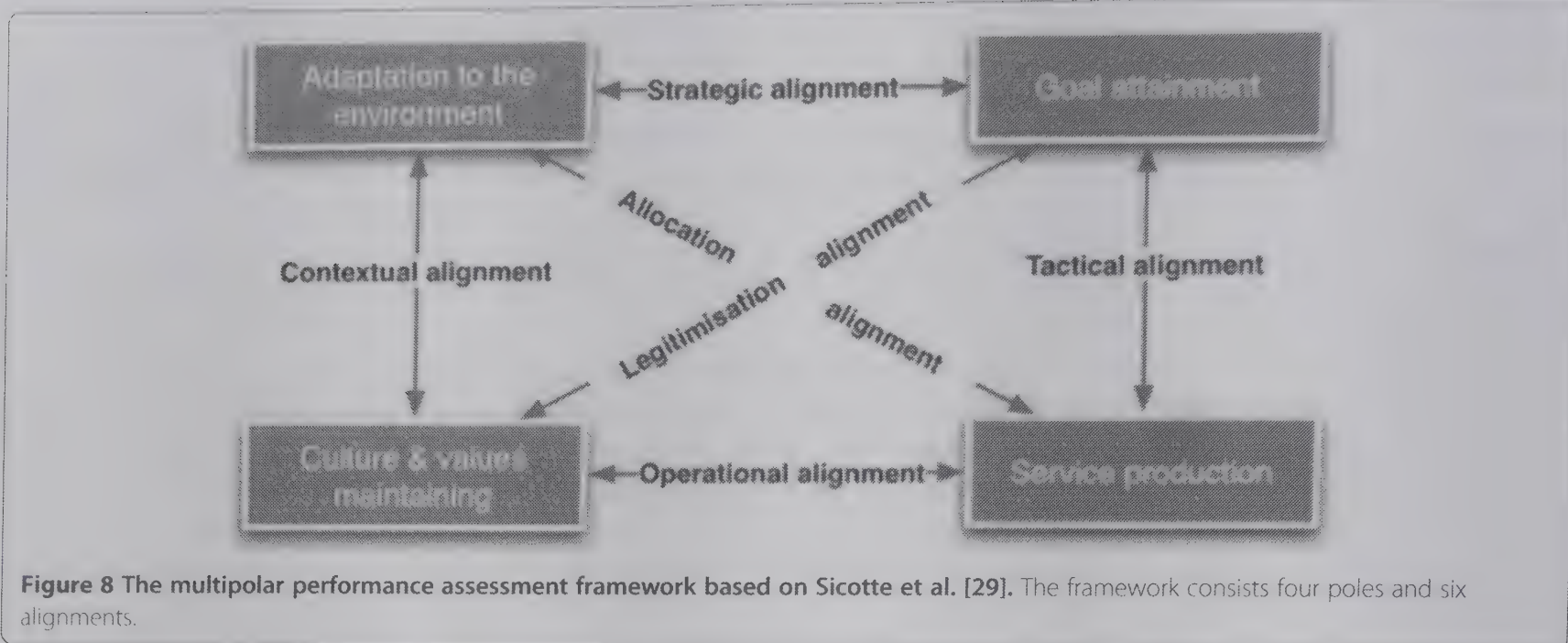
From individual change to systemic change

Although the capacity building intervention was implemented at the district level across all *talukas*, the exposure to the programme, the response to the intervention (attitudes towards change and intentions), the internal individual and organisational dynamics, and the outcomes, varied. These factors determine why programmes implemented at the district level may or may not achieve their expected outcomes, especially in those healthcare institutions where the conditions necessary for such a change do not exist. However, despite this potential for variation, formulating hypotheses in the form of CMO propositions and testing these empirically can help identify patterns of response to intervention. The resulting CMO configurations can then be refined further by testing them in other cases of the district to arrive at an explanatory theory that elucidates what worked, for whom, and under what conditions.

Capacity building interventions work through people and the choices they make. Many individual attributes, such as organisational commitment and self-efficacy, have been reported as mechanisms that explain human agency [42,44,52]. However, the *taluka* health system is more than a group of individuals with varying commitment or efficacy measures. The change in the organisation comes about through the interaction among these participants, governed by rules and norms within their organisation (the organisational culture and their activities that result in the organisational outputs), and the interaction between the organisation as a whole with the external environment. These relationships between the internal and external components of the organisation have been brought together in the multipolar framework for assessing performance of healthcare organisations, shown in Figure 8. The multipolar framework is based on Parsons' theory of social action and inspired by the work of Champ et al. [29,30,53].

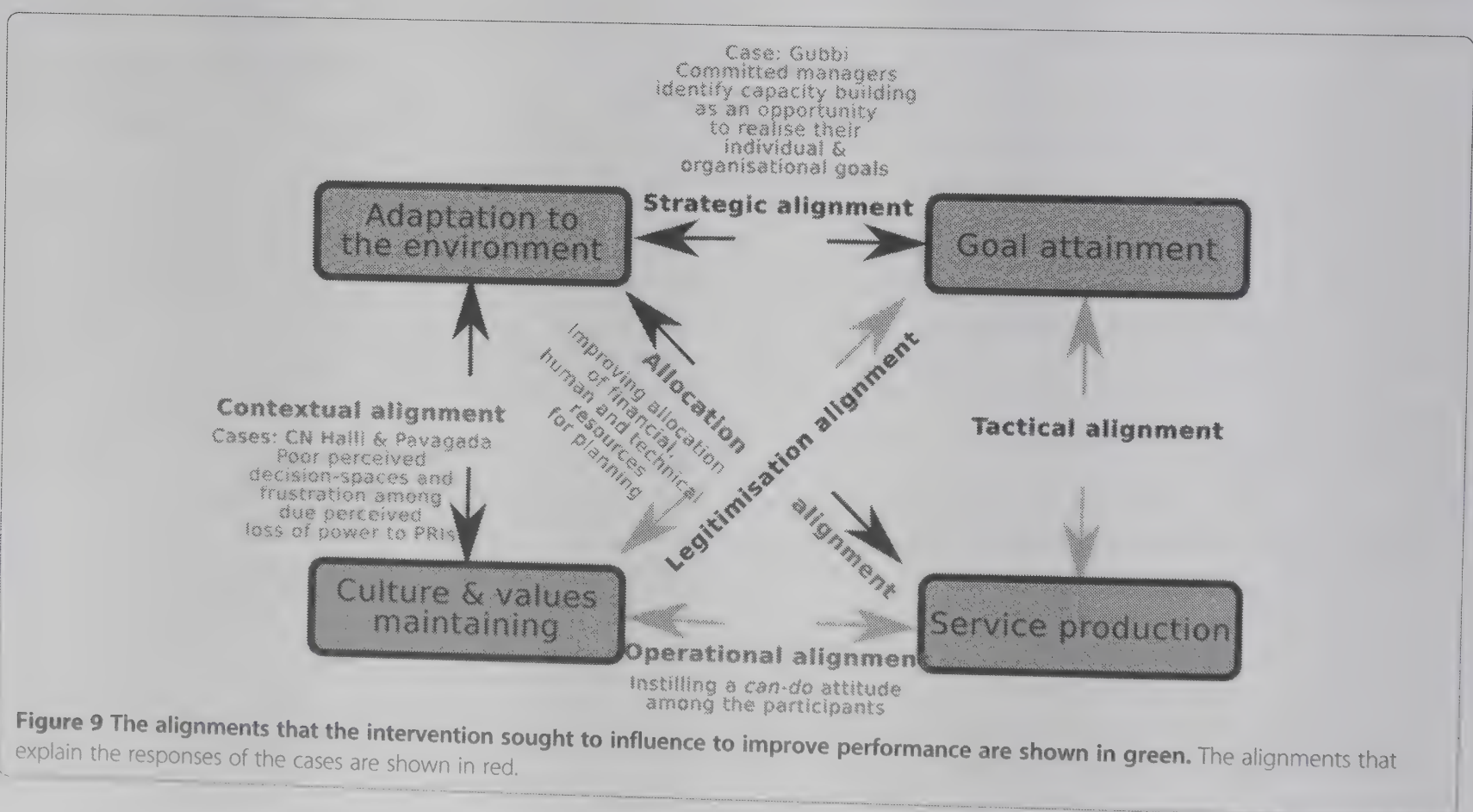
The observed changes in the *talukas* could be seen as having occurred through shifting or triggering of any of the six alignments in the multipolar framework. The *taluka* management team is responsible for managing not only the four core functions (the boxes in Figure 8), but also the alignments (the arrows in Figure 9) between the functions. The local configuration of these functions, and the management team's response to tensions between these functions explains the variation in the outcomes of the capacity building programme.

The capacity building intervention sought to alter the outputs (service production) through increasing knowledge and skills to develop annual action plans and supervision functions. An analysis of the programme theory of the intervention indicates that the designers of the intervention sought to bring about these changes through instilling a *can-do* attitude among the health



managers. This could be seen as trying to strengthen the *allocation* and *operational* alignments in the multipolar framework (Figure 8 and Figure 9). However, in the context of a health system that is undergoing decentralisation to the district levels, and where participation of elected representatives within formal structures of the health service is being increasingly pushed for by the national and state policy, the contextual alignment could dominate in some *talukas*, as was the case in CN Halli. However, a committed leadership at the *taluka* level could counter the negative perceptions of participation of elected representatives prevailing within the health service. In such cases (as in Gubbi; see Figure 9), the

legitimisation and strategic alignments could be triggered where the capacity building programme was seen as an opportunity to translate existing commitment towards the organisation into an improvement in its performance. The overall performance of the *taluka* is the result of how the alignments between the four poles are perceived locally and managed. The capacity building programme thus acts upon the *taluka* performance through imparting skills and vision to managers, who then balance or counter the emerging alignments. However, it must be emphasised that in our study, the insights from the evaluation were not periodically fed back into the system to enable the local actors (implementers



of the intervention and the recipient health managers) to benefit from or reflect on these. Realist evaluation could also be used as an entry-point for action research on local change, wherein the CMO frames being considered or the refined programme theory could be shared periodically with local actors. Furthermore, such discussions and sharing with local actors could be further used to refine or validate the middle-range theory emerging from the evaluation.

Realist evaluation and systems thinking

Realist evaluation adopts a generative perspective on causality, according to which change occurs as a result of the interaction between actors within a specific context [54-56]. A programme theory that is constructed along these lines can be tested in a reiterative manner and allows for comparison across cases. The resulting insight, in the form of a refined programme theory, informs policymakers, managers, and funders on what works, for whom, in which conditions, and how. A realist evaluation of an intervention provides an explanatory theory on why the intervention worked for some and not for others through a process of adjudication between rival explanations. By employing the classical apparatus of the scientific method – “*formulating hypotheses, making critical comparisons, discovering empirical patterns, and monitoring their scope and extent*” – realist evaluation enables a comprehensive assessment of system-wide change [15].

Limitations

The output of a realist evaluation is a programme theory or a middle-range theory (not a universal overarching theory), which provides a plausible explanation for the outcomes of the intervention; it cannot make predictive statements about the intervention. However, such middle-range theories form the basis for improving our understanding of complex interventions and help in improving design and implementation of such programmes in future.

In this paper, outliers have been purposively selected based on outcomes that are logically connected to the intervention inputs. The explanation that we provide suffers from a possible confirmation bias. Ideally, a full realist evaluation needs to refine the middle-range theory through several iterations of cases selected based on diversity of outcomes. This will strengthen the explanatory power of the middle-range theory.

In an open systems world, there is no end to the explanatory possibilities and role of other mechanisms that can be put forth and tested. Hence, a major limitation of our evaluation is the number of such rival explanatory theories that can be practically put to test. While acknowledging this practical limitation, it may be said that

a critical mass of realist evaluations will strengthen the explanatory power of the middle-range theories tested by these evaluations [15].

Endnotes

^aCritical realism is a philosophical position in social sciences that approaches causation within the social realm as being possible through rationally choosing from rival theories, thus advancing the ‘explanatory power’ of theories. According to Pratschke (2003), in critical realism, “*the ‘black-box’ of causation could be approached by understanding the gaps in the ‘generative mechanisms’ which may subsequently be explained by positing the existence of additional mechanisms at a deeper or more fundamental level*” [57].

^bBlock programme managers (BPM) are a new cadre of health managers created under the National Rural Health Mission (NRHM). These are young and typically recent graduates from management courses. BPMs operate at the *taluka* level. Similar cadres of non-medical health managers were created at the district and state levels as well.

^cThis was calculated by computing an average of percentage utilization rates of budgets of all facilities in the *taluka*/district.

^dThe National Rural Health Mission (NRHM) is a flagship programme of the Indian government to strengthen government health services through greater financial allocation and human resources. Under the NRHM, there was an induction of new cadres of health workers and health managers from village level upwards to PHC, *taluka*, district, and state levels. Decentralised planning and increased participation of elected representatives in formal structures within health services were key features of NRHM.

^ePIP stands for programme implementation plan. The PIP is the annual action plan instituted by the NRHM. As per the NRHM, the PIP is an instrument for decentralised planning.

^fZP stands for *Zilla Panchayat*, the local governments at the district level.

Additional files

Additional file 1: Abstract in Kannada.

Additional file 2: Abstract in Hindi.

Abbreviations

AMO: Administrative medical officer; CMO: Context mechanism outcome; CS: Caesarean section; NRHM: National rural health mission; PHC: Primary health centre; PRI: Panchayati Raj Institutions; THO: *Taluka* health officer.

Competing interests

NSP (first author) was a member of the implementation team of the capacity building intervention during the first year of its implementation (2009–2010). ND (third author) led the implementation of all throughout the intervention

Authors' contributions

NSP, GK, and BC conceived and designed the study. NSP developed the tools, collected data, and prepared the analysis. NSP wrote the first draft of the current manuscript with contributions from BM and BC. All authors reviewed and commented on the first draft. All authors read and approved the final manuscript.

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Advancing the application of systems thinking in health: realist evaluation of the Leadership Development Programme for district manager decision-making in Ghana

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Abstract

Background: Although there is widespread agreement that strong district manager decision-making improves health systems, understanding about how the design and implementation of capacity-strengthening interventions work is limited. The Ghana Health Service has adopted the Leadership Development Programme (LDP) as one intervention to support the development of management and leadership within district teams. This paper seeks to address how and why the LDP 'works' when it is introduced into a district health system in Ghana, and whether or not it supports systems thinking in district teams.

Methods: We undertook a realist evaluation to investigate the outcomes, contexts, and mechanisms of the intervention. Building on two working hypotheses developed from our earlier work, we developed an explanatory case study of one rural district in the Greater Accra Region of Ghana. Data collection included participant observation, document review, and semi-structured interviews with district managers prior to, during, and after the intervention. Working backwards from an in-depth analysis of the context and observed short- and medium-term outcomes, we drew a causal loop diagram to explain interactions between contexts, outcomes, and mechanisms.

Results: The LDP was a valuable experience for district managers and teams were able to attain short-term outcomes because the novel approach supported teamwork, initiative-building, and improved prioritisation. However, the LDP was not institutionalised in district teams and did not lead to increased systems thinking. This was related to the context of high uncertainty within the district, and hierarchical authority of the system, which triggered the LDP's underlying goal of organisational control.

Conclusions: Consideration of organisational context is important when trying to sustain complex interventions, as it seems to influence the gap between short- and medium-term outcomes. More explicit focus on systems thinking principles that enable district managers to better cope with their contexts may strengthen the institutionalisation of the LDP in the future.

Keywords: Continuous quality improvements, District health systems, Realist evaluation, Systems thinking

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Background

To date, the majority of management and leadership initiatives in low- and middle-income countries (LMICs) have focused on skills acquisition [1], with less attention paid to the complexity of the contexts and the health system arrangements which support or hinder such initiatives. In this paper we explore, using realist evaluation methodology, the outcomes, contexts, and mechanisms of a management and leadership initiative introduced into the district health system in the Greater Accra Region of Ghana, and whether or not such an intervention supports systems thinking in district managers. Firstly, we present an extensive background of the decision-making context at district-level. We then delve into several concepts, including systems thinking and continuous quality improvements, before discussing our analytical framework, case study design, results, and conclusions.

District manager decision-making and systems thinking

In district health systems in LMICs, district managers link the national and regional levels – where policies are formulated – to the facility and community levels – where services are delivered. District managers are responsible for providing management and leadership to supervise staff, balance resources, coordinate programmes, and network with local officials and community members, all in a specific time and place. Thus, the manner in which district managers make decisions is important. It has been argued that limited management and leadership capacities at district level contribute to bottlenecks in achieving health outcomes [2-5].

Questions pertaining to management and leadership are some of the most complex in health systems analyses, not least because developing management and leadership requires nurturing myriad individual and organisational capacities [6]. Consequently, interventions that aim to strengthen management and leadership are also complex, and engage with both individual and organisational processes. District managers find themselves navigating

complex environments in which district health systems display features of complex adaptive systems, such as self-organisation, path-dependence, emergence, and feedback loops. District health systems evolve over time as a result of multiple interactions between individuals and the system's structure [7,8]. As an approach to navigating this complexity, systems thinking aims to identify the interrelations between a system's various components [9]. Defined by de Savigny and Adam, “*systems thinking is an approach to problem-solving that views ‘problems’ as part of a wider, dynamic system*” [10]. The authors further identify a cluster of problem-solving skills relevant for systems thinking that distinguishes it from ‘usual thinking’ paradigms (Table 1). Due to their vantage point at the helm of district health systems, systems thinking can usefully support district manager decision-making.

Continuous quality improvements

Continuous quality improvement (CQI) is both a management philosophy and approach. Adopted in American healthcare institutions in the 1980s, the concept spread to LMICs during the 1990s. CQI offers a systematic way of supporting change in management processes towards improving the organisational culture of quality [12]. CQI is based on the assumption that problems within organisations are not rooted clinically or administratively, but are rather systemic and arise out of structural inabilities to perform as intended [13]. McLaughlin and Kaluzny identify nine elements necessary to classify an approach as CQI (Table 2). Systems thinking is embedded within this constellation, and can be seen as the glue that binds CQI elements together (the authors refer to this as ‘systems-view’).

To date, the impact of CQI in sub-Saharan Africa has been mixed. Case studies from three countries have demonstrated several factors that contribute to reduced CQI sustainability and effectiveness [14]. These are: i) introducing quality management as a vertical programme; ii) lacking systemic perspectives and identifying problems in

Table 1 Systems thinking skills

From ‘usual thinking’ approaches...	...to systems thinking
Focused on particular events (<i>Static thinking</i>)	Problems framed in terms of a patterns of behaviour over time (<i>Dynamic thinking</i>)
Focused on particular details (<i>Tree-by-tree thinking</i>)	Focused on understanding the context of relationships (<i>Forest thinking</i>)
Focused on factors that influence/correlate with results (<i>Factors thinking</i>)	Focused on causality and understanding how behaviour is generated (<i>Operational thinking</i>)
System-generated behaviours are driven by external forces (<i>Systems-as-effect thinking</i>)	System-generated behaviours are driven by internal actors who interact with system itself (<i>Systems-as-cause thinking</i>)
Causality is viewed as uni-directional, without interdependence or interactions between causes (<i>Straight-line thinking</i>)	Causality is viewed as ongoing with feedback effects, including interdependence and interactions between causes (<i>Loop thinking</i>)

(Adapted from Richmond, 2000 [11]).

Table 2 Elements of continuous quality improvements

Element	Description
Systems-view	Emphasis on analysis of the whole system providing a service, or influencing an outcome
Customer focus	Emphasis on both customer (patient, provider, payer) satisfaction and health outcomes as performance measures
Data-driven analysis	Emphasis on gathering and use of objective data on system operations and system performance
Implementer involvement	Emphasis on involving the owners of all components of the system in seeking a common understanding of its delivery process
Multiple causation	Emphasis on identifying the multiple root causes of a set of system phenomena
Solution identification	Emphasis on seeking a set of solutions that enhance overall system performance through simultaneous improvements in a number of normally independent functions
Process optimisation	Emphasis on optimising a delivery process to meet customer needs regardless of existing precedents, and on implementing the system changes regardless of existing territories and fiefdoms
Continuing improvement	Emphasis on continuing the systems analysis, even when a satisfactory solution to the presenting problem is obtained
Organisational learning	Emphasis on organisational learning so that the capacity of the organisation to generate process improvement and foster personal growth is enhanced

(Adapted from McLaughlin and Kaluzny, 1994 [13]).

their own sub-systems; iii) oversimplifying decision-making through the use of toolbox techniques; and iv) the conundrum of organisational culture and quality management: does organisational culture change to modify practise, or does organisational culture change by modifying practise? Furthermore, CQI is always implemented within an organisation's own context – its history, cultural norms, and values. This latter point contributes to understanding the 'inherent duality' of CQI, namely that its principles are based on two distinct, paradoxical goals: although CQI promotes organisational control, uniformity, and standardisation, it also gives rise to organisational creativity, learning, and cultural change. This means that CQI practise (and the mechanisms behind it) will vary depending on whether its underlying goal is organisational control or organisational learning. Related to this, CQI's underlying goal will be driven, either implicitly or explicitly, by the culture and structure of the organisation itself. Sitkin et al. [15], suggest that the most likely goal is informed by the degree of organisational uncertainty: when uncertainty is high, the organisation is predisposed to learning because control, in a sense, is out of reach. On the other hand, when contextual uncertainty is low, the organisation is predisposed to control because the problem is well understood and can be dealt with mechanistically. CQI has been proposed as a potential solution to improving service delivery in Ghana [16].

Implementing the Leadership Development Programme in the Greater Accra Region

In Ghana, district managers are staff of the Ghana Health Service (GHS)^a. The context of district manager decision-making is such that resource decisions (human, material, and financial) are constrained. This is partly due to the hierarchical structure of the GHS in which decision-making remains highly centralised, and resources scarce [17,18]. District managers have more discretion around programming decisions. Formalised management training is limited, and most managers learn their management roles on the job. Additionally, managers face serious time constraints due to concurrent scheduling of vertical and donor programme activities.

The LDP has been intermittently implemented in Ghana since 2008. Developed by Management Sciences for Health [19], the LDP has been implemented in several countries including Egypt [20], Kenya [21,22], and Mozambique [23]; the Greater Accra Region first introduced the LDP in 2010. In 2011, the LDP was proposed as an approach to address limited responsiveness, lacking leadership, and mismatched resources indicated as bottlenecks to improving maternal and newborn (MNH) service delivery [24]^b. The LDP is designed for teams to apply 'leading and managing' practices to service delivery problems (referred to as 'challenges' in the LDP – Table 3). This is realised through teamwork, defining root causes, action planning, monitoring, and evaluation, and repeating the cycle. Its programme theory puts forth that, when deployed in tandem, leading and managing practices improve work climate, management systems, and capacity to respond to change, and ultimately result in better services and health outcomes. However, the programme theory is based on LDP content alone and does not account for differential impacts in various contexts.

A review of the LDP suggests that it draws upon CQI principles in its approach. The LDP acknowledges the complex environment of managerial decision-making, and states that sustaining advances in health outcomes only occurs when leading and managing practices are absorbed into routine practise (i.e., their institutionalisation). However, the LDP is not explicit about this theoretical basis in CQI, nor does it claim systems thinking as a prime objective. We recognise that CQI philosophy – and implicitly, systems thinking – is embedded within the LDP practise and tools, and we were therefore interested in understanding the degree to which the LDP can stimulate systems thinking in district teams. Though the language differs, the concepts of systems thinking, CQI, and the LDP overlap in their approach to shifting problem-solving towards a more systemic orientation for improved decision-making: if systems thinking is the capacity to see interrelationships between components of a system, CQI is the process of managing these interrelationships, and the LDP is a practical intervention to implement these principles. This overlap is illustrated in Figure 1.

Table 3 LDP leading and managing practices

Leading practices	
Scanning	Identifying client priorities and needs
	Seeing opportunities, trends, constraints and risks (Organisational outcome: valid, current knowledge of context)
Focusing	Developing shared goals
	(Organisational outcome: articulated mission, vision, strategies and priorities)
Aligning/ mobilising	Building congruence between values, mission, structures and daily actions
	Supporting teamwork (Organisational outcome: external and internal stakeholders have ownership over organisational goals and support resource mobilisation towards these goals)
Inspiring	Building trust and acknowledging team members
	Modelling creativity and learning (Organisational outcome: climate of continuous learning with committed staff)
Managing practices	
Planning	Identifying goals, annual plans and performance objectives
	(Organisational outcome: defined results and matching resources)
Organising	Ensuring accountability and authority structures
	Aligning staff capacities with planned activities (Organisational outcome: functional structures and processes for operations)
Implementing	Integrating workflows and systems
	Balancing competing demands (Organisational outcome: effective, efficient and responsive actions)
Monitoring and evaluation	Reflecting on progress against action plans
	Improving work processes and procedures (Organisational outcome: continuous up-to-date data for decision-making)

(Adapted from Mansour et al., 2005 [19]).

The objectives of our study, therefore, are to understand: a) the mechanisms by which a complex intervention introduced into a complex context brings about its observed outcomes (i.e., how and why does the LDP ‘work’ when it is introduced into a district health system in Ghana); and b) whether or not the LDP increases systems thinking in district managers in this context.

Methods

Study setting

The LDP was introduced in a rural district, Dangme West^c. The study took place from November 2011 to August 2013. An initial period of participant observation prior to the onset of the intervention lasted from November 2011

to January 2012. The LDP intervention was implemented from February to August 2012, and a follow-up period of participant observation extended until August 2013.

District managers were defined as: i) members of the district health management team (DHMT); ii) members of the district hospital management team; and iii) members of the three sub-district health teams. These managers were selected because they represent top-level management for decision-making within the district.

Description of the LDP intervention in Dangme West

The LDP was introduced to district teams (district health administration, district hospital, and three sub-district management teams) by a facilitation team consisting of three members of the regional health administration, and one external consultant specialised in the LDP. The curriculum, teaching materials, and learning strategies were based on the LDP Handbook [19]. The LDP consists of a six-month cycle of root challenge identification, action planning, and monitoring and evaluation. For each training workshop, district teams consisted of 4 to 7 members per team, depending on the size of the facility. These were managers (core management including medical superintendents, district directors of health services, deputy directors of nursing services, physician assistants, and hospital administrators), and staff (accountants, public nursing officers, and midwives). Two-day, face-to-face workshops were held in the capital city Accra three times bi-monthly. These involved modules on LDP practices, developing a shared team vision, diagnosing challenge root causes, developing action plans, setting priorities, mobilising stakeholders to commit resources, monitoring and evaluation, understanding roles in teamwork, and building trust. Workshops were interspersed with monthly coaching visits, with the facilitation team attending teams and their wider staff in their facilities to ensure organisation-wide diffusion of LDP teachings. For their LDP results, each team identified one MNH-related challenge they wished to address (Table 4). Every team attained their planned results except for one sub-district team; at the time, the health facility did not have a resident midwife and thus faced difficulties in improving its skilled delivery coverage.

Study design: realist evaluation

We used a case study design as most appropriate for organisational studies in which ‘how’ or ‘why’ questions are being asked. Criticisms of case study designs include their weak external validity [25]. Seeking to address this criticism through cumulative validation, realist evaluation is an approach capable of addressing complex investigation and probing causal linkages between contexts, actors, and the changes observed. Realist evaluation attempts to move

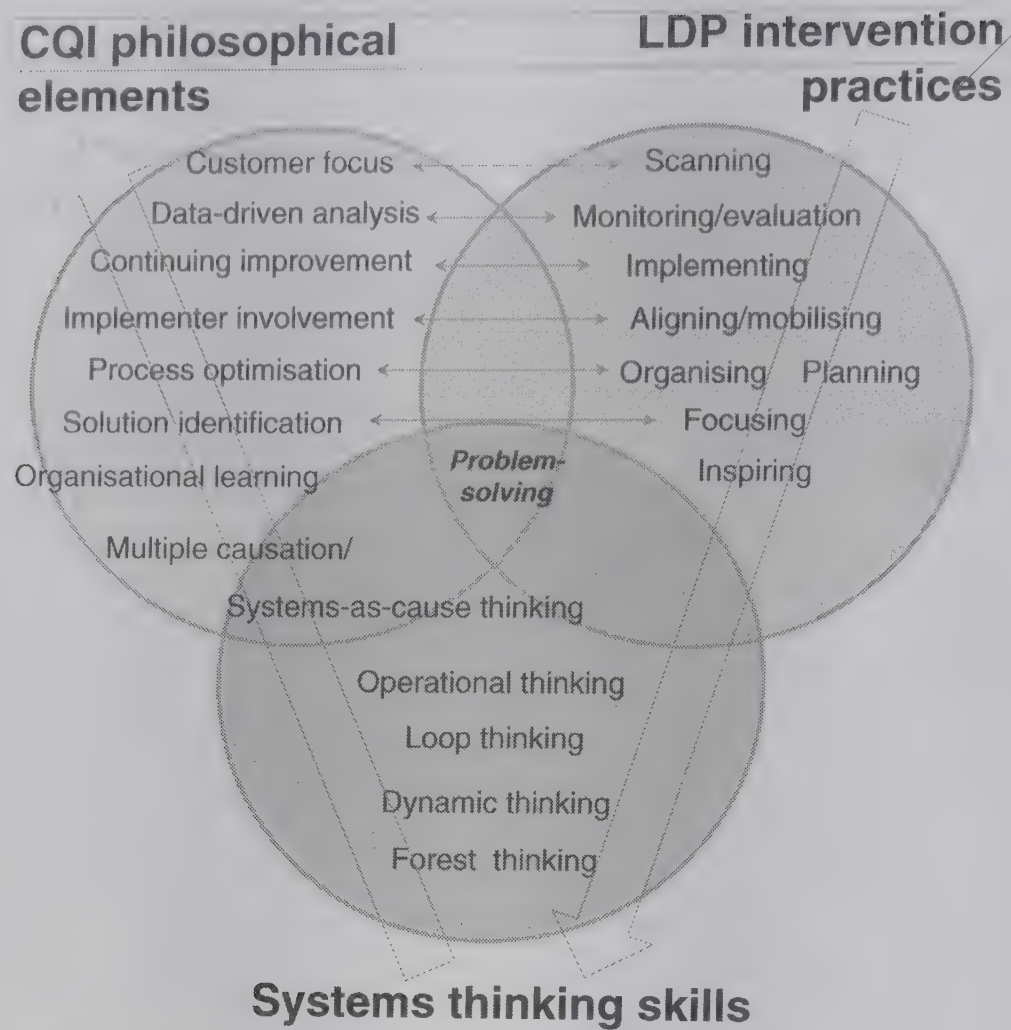


Figure 1 Overlap in problem-solving approach between systems thinking, CQI, and the LDP.

beyond asking ‘did the intervention work?’ towards understanding ‘how did the intervention work, for whom, and in which contexts’ [26-29]? The case study begins with the formulation of the middle range theory (MRT), based on existing theory and past actor experience. The MRT, structured as a ‘context + mechanism → outcome’ (CMO) configuration, is validated with actors, and against the literature. The validated MRT then becomes the working hypothesis to be ‘tested’ in the case. It is subject to revision based on accumulated new evidence.

Analytical framework: our middle range theory

Context of district manager decision-making (C)

The first part of developing our MRT included an in-depth exploration of the decision-making context for district managers in Ghana. Based on our pre-LDP observation period, we found that district managers have

narrow decision-space due to the highly-centralised authority within the GHS. National-level control over resources leads to resource uncertainty at district level. Through formal and informal communication channels, district managers engender trust and employ it as a coping mechanism to counter organisational uncertainty and manage the risk of not fulfilling their managerial mandates of oversight, coordination, and networking in the face of resource scarcity. Trust and respect for regional- and national-level authorities further legitimises the system’s hierarchy, thereby reinforcing it [unpublished observations]. This decision-making ‘loop’ is the context into which the LDP was introduced.

Outcomes of the LDP – short- and medium-term (O)

Furthermore, we worked backwards from the observed short-term outcomes of the LDP (i.e., LDP results) and

Table 4 LDP results (short-term outcomes) February to August 2012

Team	LDP challenge	LDP results (short-term outcome)
District Health Administration	Increase skilled delivery from 37% to 40%	Increased skilled delivery to 51%
District Hospital	Reduce still birth from (n=) 30 to 20	Reduced still birth to (n=) 11
Sub-district 1	Increase skilled delivery from 15% to 18%	Increased skilled delivery to 19%
Sub-district 2	Increase skilled delivery from 1.7% to 5%	Increased skilled delivery to 2.6%
Sub-district 3	Increase focused antenatal care from 0 to 20%	Increased focused antenatal care to 22%

medium-term outcomes, which were interpreted as the residual organisational changes (i.e., LDP institutionalisation). These included new organisational roles and relationships as a result of the LDP, extensiveness (i.e., how widely disseminated across the organisation) and intensiveness (i.e., how deeply integrated into routine practice) of the LDP, and any organisational routines displaced by the LDP [30].

Mechanisms of the LDP (M)

Through our MRT, we attempt to uncover the mechanisms of the LDP. Our beginning assumption was that if systems thinking took place as a result of LDP practices, this would support LDP institutionalisation. In a feedback mechanism, institutionalisation of the LDP would further increase systems thinking. We hypothesised our MRT as follows:

The LDP brings about its short-term outcomes by encouraging district managers to seek alternative sources of financial and material resources. If successful, the increased ability to look within and across the district for resources: i) supports relationship building with district stakeholders, which improves the number and quality of district relationships; ii) expands managerial understanding of the linkages and interactions in the district health system, which deepens systems thinking in managers, and supports LDP institutionalisation; and iii) reduces resource uncertainty, which lessens managerial risk, and thus the need to draw upon trust and respect as coping mechanisms. Reduced resource uncertainty increases district manager decision-space. Reduced uncertainty triggers the LDP's underlying focus on organisational control.

Rival MRT

We also propose a rival MRT where the LDP brings about its short-term outcomes by reinforcing hierarchical authority, because it is introduced in a top-down manner. As such, resource uncertainty remains high, and district manager decision-space narrow. Thus, district managers continue to rely on trust and respect as coping mechanisms to deal with resource uncertainty. The context of high uncertainty triggers the LDP's underlying focus on organisational creativity. This focus on creativity stimulates systems thinking, which supports LDP institutionalisation.

Data collection

Document review

For data on the LDP implementation, we reviewed weekly district management team meeting minutes and monthly regional management team meetings for the duration of the study period, as well as all training workshop materials, team presentations and action plans, and reports from previous LDP cycles in other regions. For overall context, we

further reviewed national, regional and district policies, and protocols (Additional file 1: Table S1).

Participant observation

For the duration of the study period, the first author participated in weekly district health management meetings, monthly regional health management team meetings, semi-annual district planning and district review meetings, all LDP training workshops and coaching visits, teams' LDP activities, DHMT supervisory visits to sub-districts, and day-to-day operations of the district. Until October 2012, the third author participated in monthly regional health management team meetings. Continuous discussion with management and staff was the method of sense-making used. As part of their routine management meetings, validation workshops took place at the end of the initial and follow-up observation periods to feedback findings to district teams and integrate their views into the analysis.

Semi-structured interviews

We conducted a total of 23 interviews with members of the DHMT (8), district hospital management (4), and sub-district management (7); 4 managers were lost to staff transfers (2 from the DHMT and 2 at the sub-district level). At the regional level, we interviewed 3 out of 4 members of the LDP facilitation team, and one development partner supporting the LDP; 17 respondents were women and 6 were men; 3 respondents were in their current posting less than 1 year, 13 between 1–3 years, and 7 between 3–5 years. More than half the respondents (12) had no prior formalised management training.

Interview guides were developed to investigate team perceptions of quality, actual LDP implementation (including challenges and functioning), influence of concurrent district initiatives, organisational sustainment of LDP practices, and changes in relationships and resources. Interviews took place 8 months after the end of the LDP.

Data analysis

Audio-recorded interviews were conducted in English, and observational field notes were converted into transcripts, cleaned, and entered into Atlas.ti[®] qualitative analysis software. Transcripts were coded against an initial start-code list developed from systems thinking, LDP, CQI concepts, and our MRTs. Emerging themes from the data were also coded. In order to 'configure' our CMOs [31], we began with the short-term outcomes. We triangulated across data type and source to systematically arrange our medium-term outcomes and unearth potential mechanisms of the LDP. We then drew out linkages between the contexts, outcomes, and identified mechanisms in a causal loop diagram (CLD).

Ethical considerations

This study was part of a larger study to identify effective ways of improving MNH service delivery, for which ethical approval was awarded by the Ghana Health Service Ethical Review Committee. Teams were made aware of the observation periods. Respondents participated voluntarily, and were able to withdraw at any time. Informed consent was obtained from all respondents, and respondent anonymity was maintained during all parts of the study using coding.

Results

LDP as it was implemented

The LDP was mainly implemented as designed. During implementation, the LDP was frequently discussed as part of management team meetings, and was often mentioned at the monthly regional health management team meetings.

The LDP training approach was more team-based, less didactic, and more intensive than most district workshops. Modules focused more on the deployment of LDP tools and proceeding through LDP processes, and less on facilitating teams to reflect on their own organisational practices or thinking systemically through them. This was indicated in the first LDP workshop, where facilitators identified the programme goals as being: i) to learn how to lead and manage to enable others to face challenges and achieve results; ii) to apply tools to analyse challenges to achieve results; iii) to know how to produce measurable results; and iv) as managers, to learn how to build a positive work climate. The emphasis was more on the LDP's 'managing' rather than 'leading' practices.

A review of teams' LDP action plans and presentations showed that teams broadly undertook two categories of activities: i) community sensitisation and customer care training for frontline staff, or ii) lobbying local organisations for material resources. From the customer care training workshops we found clear patterns of hierarchy being reinforced. Customer care workshops were facilitated by non-LDP regional staff and were regarded as 'customer care as corporate responsibility, to redeem the corporate image'. In part, this stemmed from some high-profile media cases about staff error. Emphasis was placed on rules and regulations of the GHS, proper comportment of staff in forms of address towards their seniors, and dress codes. Very little related to client-provider relationships and there was minimal opportunity for staff to reflect on their experiences with clients. Furthermore, in performing their root cause analyses, teams were not trained to investigate the interrelationships between different causes, but rather to deal with single root causes separately. Taking the example of poor staff attitude, teams worked through their root cause analysis in the following manner:

"staff attitude is poor, because staff lack courtesy and good customer care; this is because they have inadequate knowledge about good customer care; which is because they have not been trained on good customer care; therefore the solution is to provide customer care training."

An example of gaps between LDP practise in the context of its implementation and LDP practise in routine work was observed 2 weeks prior to the final LDP workshop. In one sub-district, having been called to assist in a conflict between staff and management, DHMT members resolved the situation by stating:

"Any time your leader tells you something, she has a plan. Only one person can lead, others follow faithfully. Yours is to do what you are told. The rest, she will manage".

Once ended, there was little evidence of teams' efforts to support LDP institutionalisation. None of the five teams engaged in another LDP cycle, no new staff were oriented in the LDP, no funds were set aside for LDP activities, and meeting minutes and staff conversations no longer reflected mention of the LDP. The lack of team efforts towards LDP institutionalisation was influenced to some extent by time constraints of routine district work: at the time the LDP ended (August–September), district teams were focused on completing year-end activities and reporting, and preparing for a new planning cycle. LDP institutionalisation was further compromised by changes of leadership at regional, district, and sub-district levels, which witnessed the appointment of new directors at each level. Critically, the splitting of the district into two separate districts in October 2012 required new administrative structures in the new district, and a restructuring of relationships across both districts. It does not appear that teams used their LDP practices to support these transitions. Several months after the end of the LDP, the majority of team members could not list the LDP practices. The LDP did not appear to support the development of systems thinking in district managers.

Participant perceptions of the LDP

The introduction of the LDP from the region was unexpected by district teams, and was not initially part of their annual work plan. However, in the context of verticalised programming, this is common. The facilitation of the LDP by the region was perceived in two distinct ways. From the regional perspective, facilitating the LDP provided an opportunity to remind district teams of 'proper conduct', part of which was complying with regional directives. From the district perspective, having regional facilitators participate during coaching visits, heightened the experience:

"These big, big, top, top, top, people were here. It's not the normal people like we that they [the staff] are used to. So that one alone will give them some inspiration..." (DHMT member)

Since the teams had little formalised management training, the novelty of the LDP disposed them to being receptive to capacity support. The exposure to management practices enabled teams to attain their LDP results, and they noted that the imposition of deadlines created a sense of urgency and increased the need to attain results, compared to their routine targets. The LDP also helped managers build initiative. Managers acknowledged that some problems were 'beyond' them, and therefore, initiative-taking was encouraged, but only on a 'small-scale':

"You are supposed to make do with what you have. Because sometimes when we have challenges we think that 'oh as for this one, we are waiting for region to come and do it, or we are waiting for national to come and do it'. LDP says you shouldn't think so big, but something within... you should just try to think around yourself". (DHMT member)

Managers learned to better prioritise and felt more able to manage concurrent programmes, and thus viewed themselves as working more efficiently. Supporting teamwork through inspiration and acknowledgment was also important. One manager stated that prior to the LDP she used to ignore her staff if they incorrectly performed a task. Managers did note that the LDP had no influence on the relationship between district and regional levels, nor did it alter the dynamics around resources:

"It hasn't changed our resources. If I am saying the truth, I don't think we have the resources to work with". (Sub-district head)

One issue reported consistently by district managers was the LDP's resource intensiveness. Convening stakeholders and running training workshops all require additional funds, which was perceived as burdensome, since teams had severe resource constraints and had not budgeted for the LDP in advance. Lobbying for funds from the District Assembly was difficult as the annual planning cycle had already passed. Furthermore, the time required to meet for LDP activities, convening the wider team, and preparing plans was viewed as onerous in the face of concurrent programmes and other health system constraints. One manager highlighted the difficulty that under-staffing created in trying to gather staff for training without disrupting service delivery:

"The challenges that we had in implementing the LDP were trying to get staff themselves to come around to listen to us. It's terrible, the beginning it was very hard to get the unit heads to come around. The reason was that due to lack of staff. The unit heads must be there to monitor, and there is no staff to bring to come and listen to us." (Hospital management)

Managers widely perceived the lack of LDP institutionalisation as related to the LDP being a 'regional project':

"You can also see that at the regional level it has ended. So if the regional level it has ended can the district continue? Since then there has never been any coach from region to come and see what we have done, where we have reached and what the challenges are. So you can imagine, we at the sub-district can we also do it? So me, it is not about the district not doing it or it's not implementing it, I only see it as a project...at the [LDP workshops] we were told it is not a project, it is a running thing. But it has ended as if it is a project and the project has come to an end." (DHMT member)

Proposing causal linkages (C + M → O)

We illustrate the relationships between our contexts, mechanisms, and outcomes in a CLD^d (Figure 2). This schema represents causation between variables, with directions of influence depicted by arrows. Influence in the same direction is represented by positive arrows. Feedback loops can reinforce (R) or self-regulate the pathway [32].

Our CLD shows the pathway of the LDP's short-term outcomes (right-side of the figure, thin arrows) and medium-term outcomes (left-side of the figure, thick arrows). On the short-term, the novelty of the LDP for managers with limited formalised management training (C) stimulated the value and utility of bundled management practices taught by the LDP (M) for teams to achieve their LDP results (O). This causal pathway is linear, and does not significantly deviate from the predicted programme theory of the LDP. On medium-term outcomes, the introduction and facilitation of the LDP in a top-down manner (i.e., from the region) (C) promoted hierarchical authority and triggered the LDP's focus on controls and standardisation (M). Multiple, reinforcing feedback mechanisms (R1 and R2) neither supported LDP institutionalisation, nor systems thinking among district teams (O).

Had our original assumption been borne out, we would see a third reinforcing loop (R3) between systems thinking and LDP institutionalisation. For simplicity sake, we redraw the same analysis as a causal tree diagram (Figure 3).

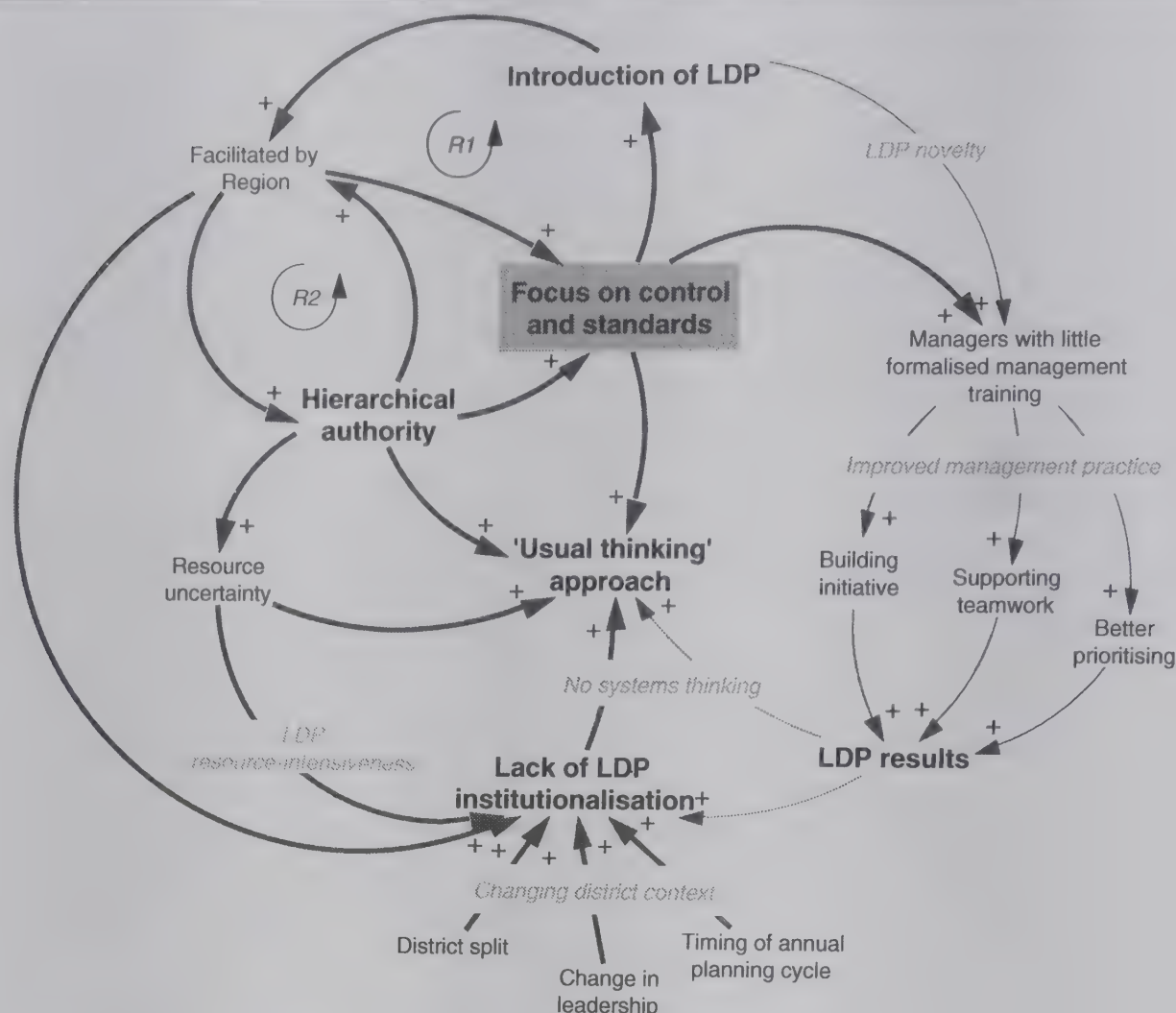


Figure 2 Causal loop diagram of LDP implementation, February to August 2012.

Discussion

Hawe et al. [30] suggest that the most important dimension of complexity is frequently not the complex intervention itself, but rather the context into which it is introduced. We found that in trying to produce change in a complex adaptive system, the LDP in this case could not be sufficiently institutionalised. In essence, the system 'rejected' it and returned to its prior equilibrium. The context of system hierarchy, as demonstrated by the deployment of regional staff to train the districts, highlights the cascading approach to systems change from the top. This may not always be appropriate, and further underscores the need to think systemically when introducing any intervention. We note that, in this case, the LDP appeared to engage systems thinking in its tools rather than through its practices, and incorporated its CQI elements in its organisational outcomes rather than its processes. This suggests a focus on organisational control, rather than creativity, of both the LDP and the organisational context into which it was introduced. Being tool-driven, the LDP does not itself provide processes for developing a learning organisation, and we noted no evidence of new mental models created in district teams – what Sterman [33] distinguishes as 'single-loop' versus 'double-loop' learning. Our study raises questions about the nature of management and leadership capacity

strengthening. We recognise that short-term capacity strengthening interventions may not necessarily support such reorientations. As such, it is critical for donor partners and national governments to reconsider the types of idealised interventions often put in place, and how contexts can modulate expected outcomes over time. This suggests support for longer term, more reflective, and potentially unpredictable capacity strengthening approaches. This notion is further supported by a recent study from Rwanda that found no statistical association between training and adherence to recommended MNH practise [34]. Our findings uphold earlier work by Blaise and Kegels [35], who describe the rigidity and lack of responsiveness in command-and-control structures observed in several African health systems as contributors to quality of care challenges in service delivery.

At the outset we hypothesised that, in reinforcing system hierarchy, the LDP's underlying goal of organisational creativity would prevail due to the context of high uncertainty. Paradoxically, the LDP's underlying goal of organisational control was more pronounced. We attribute this to the degree of centralised decision-making in the system: the strength of 'command-and-control' overrides other mechanisms that enable learning, creativity, and adaptability. This mismatch in contextual uncertainty and organisational culture may very well account

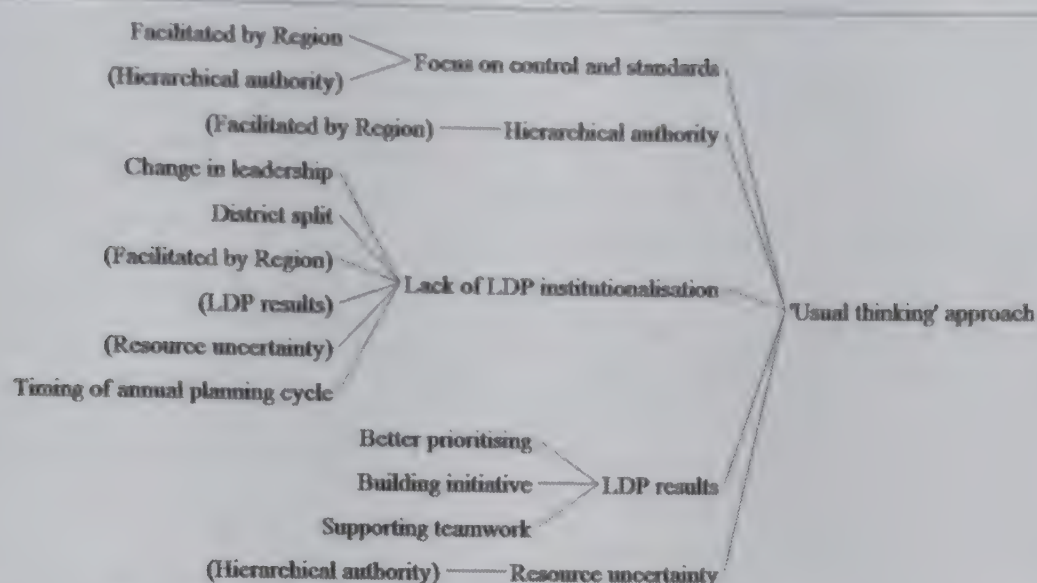


Figure 3 Causal tree diagram of LDP implementation, February to August 2012.

for the lack of effective management at district level. With this in mind, we refine our MRT as follows:

The LDP brings about its short-term outcomes through its experience of novelty, building initiative, supporting better prioritisation, and building teamwork. The LDP reinforces hierarchical authority due to being introduced in a top-down manner. As such, resource uncertainty remains high and, as a consequence, district manager decision-space remains narrow. Thus, district managers continue to rely on trust and respect as coping mechanisms to deal with resource uncertainty and their managerial risk. The context of high uncertainty, coupled with reinforced hierarchical authority, triggers the LDP's underlying focus on organisational control. Systems thinking is not stimulated, and LDP institutionalisation does not occur.

In thinking about how the LDP might have been implemented differently, we consider five ways in which the causal pathway could have been altered: i) had the LDP facilitators been peers instead of superiors (for example, training teams could have consisted of district managers whose districts had previously undertaken the LDP rather than being regional officers), this may have weakened hierarchical authority, thereby reducing the top-down nature of its introduction; ii) had districts volunteered to receive the LDP instead of being randomly selected, they may have expected it and better prepared their resources; iii) had ongoing mentorship and coaching been built into the process through systematic follow-up, this may have supported the view of greater district ownership; iv) had the timeframe of the LDP intervention been lengthened to include two or three cycles, this may have had longer-lasting effects and become routine practise; and v) had organisational creativity and learning been an explicit goal, with reflective processes as a major part of the intervention, this may have provided greater opportunity for more systems thinking to develop in district managers. We recommend that the LDP could be strengthened by a more

explicit integration of CQI philosophy and principles into its existing tools, and greater attention paid to context to support its institutionalisation. We are aware of existing CQI-based interventions in the Ghanaian health system with similar 'Plan-Do-Study-Act' cycles, indicating that the lack of institutionalisation of one programme does not prevent the implementation of other similar interventions.

Our findings clearly demonstrate that a lack of consideration of the context into which such interventions are introduced can minimise their effectiveness. More importantly, our work highlights the fact that context also informs the kind of management and leadership that emerges at district level. Not uniquely a Ghanaian challenge, decision processes are often rooted in a desire for control and prediction, such that managers who cannot deliver are perceived as ineffective and are soon replaced [36]. These issues exceed the scope of our study, but do underscore the fact that improvements in management and leadership do not reside in the capacities of managers alone, but demand keen attention to the organisational contexts in which managers are embedded.

A limitation of our study is that it reports on only one context for LDP implementation. This is a first level analysis; moving forward we expect to conduct a wider exploration of other districts in the Greater Accra Region and further refine our MRT.

Conclusions

The influence of contexts on mechanisms in the gap between short- and medium-term outcomes is particularly important given that decisions to scale-up interventions are frequently based on their success in the short term. In the Ghanaian context, introducing the LDP into a context of highly centralised decision-making and resource uncertainty triggered its underlying goal of organisational control. More explicit focus on systems thinking principles that enable district managers to better cope with their contexts

may strengthen the institutionalisation of the LDP in the future.

Endnotes

^aThe Ghana Health Service (GHS) is the semi-autonomous agency of the Ministry of Health responsible for public health service delivery. Since its creation in 1996, the GHS has been administratively decentralised along national, regional, and district lines. National-level GHS is responsible for policy direction. Regional health directorates provide technical and administrative oversight to district health directorates responsible for coordinating service provision at district and sub-district level.

^bThis was as part of a larger study to improve service delivery for MNH. One key aspect of the study sought to support managerial decision-making as part of the overall organisational change needed to improve MNH quality in the Greater Accra Region. The larger study envisioned designing and implementing a CQI programme to address this. However, given the existence of the LDP already in the health system, and its overlap in approaches and philosophy with CQI, the LDP was instead identified as the CQI-based intervention to be evaluated.

^cDangme West was subsequently divided into two separate districts: Shai-Osudoku District and Ningo-Prampram District; this paper reports its findings against the district structure at the time of the study.

^dWe drew Figures 2 and 3 using Vensim simulation software : www.vensim.com.

Additional file

Additional file 1: Table S1. Policy documents and reports reviewed.

Abbreviations

CQI: Continuous quality improvements; CLD: Causal loop diagram; CMO: Context-mechanism-outcome configuration; DHMT: District health management team; GHS: Ghana Health Service; LDP: Leadership Development Programme; LMIC: Low- and middle-income country; MNH: Maternal and newborn health; MRT: Middle range theory.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

Conceived and designed study: AK, IAA, HvD. Developed instruments and collected data: AK, IAA. Analysed data: AK, IAA, HvD. Wrote and reviewed manuscript: AK, IAA, HvD. All authors read and approved the final manuscript.

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Advancing the application of systems thinking in health: South African examples of a leadership of sensemaking for primary health care

Lucy Gilson^{1,2*†}, Soraya Elloker^{3†}, Patti Olckers^{4†} and Uta Lehmann^{5†}

Abstract

Background: New forms of leadership are required to bring about the fundamental health system changes demanded by primary health care (PHC). Using theory about complex adaptive systems and policy implementation, this paper considers how actors' sensemaking and the exercise of discretionary power currently combine to challenge PHC re-orientation in the South African health system; and provides examples of leadership practices that promote sensemaking and power use in support of PHC.

Methods: The paper draws on observational, interview, and reflective data collected as part of the District Innovation and Action Learning for Health Systems Development (DIALHS) project being implemented in Cape Town, South Africa. Undertaken collaboratively between health managers and researchers, the project is implemented through cycles of action-learning, including systematic reflection and synthesis. It includes a particular focus on how local health managers can better support front line facility managers in strengthening PHC.

Results: The results illuminate how the collective understandings of staff working at the primary level - of their working environment and changes within it - act as a barrier to centrally-led initiatives to strengthen PHC. Staff often fail to take ownership of such initiatives and experience them as disempowering. Local area managers, located between the centre and the service frontline, have a vital role to play in providing a leadership of sensemaking to mediate these challenges. Founded on personal values, such leadership entails, for example, efforts to nurture PHC-aligned values and mind-sets among staff; build relationships and support the development of shared meanings about change; instil a culture of collective inquiry and mutual accountability; and role-model management practices, including using language to signal meaning.

Conclusions: PHC will only become a lived reality within the South African health system when frontline staff are able to make sense of policy intentions and incorporate them into their everyday routines and practices. This requires a leadership of sensemaking that enables front line staff to exercise their collective discretionary power in strengthening PHC. We hope this theoretically-framed analysis of one set of experiences stimulates wider thinking about the leadership needed to sustain primary health care in other settings.

Keywords: Discretionary power, Complex adaptive systems, Front line workers, Leadership, Primary health care, Sensemaking

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Background

Reform and renewal are fundamental features of every health system, though the ambition and scale of change varies over time and between countries. Twenty years after the election of its first democratic government, South Africa continues to strive for an improved health system – a health system that better meets the needs and preferences for treatment, care, and dignity, of all its population. The fragmented health system inherited from the previous era, with multiple organizational structures, levels, and programmes, was shaped by the perverse political and economic goals of the Apartheid state [1]. Various policy, organizational, and resource allocation reforms have been implemented since 1994 to re-orient the system towards population health need and equity goals. Nonetheless, recent reviews have highlighted slow progress, particularly in establishing a functional district health system (DHS) as a basis for strengthening primary health care (PHC) [2,3]. Towards Universal Health Coverage, and in line with global policy directions [4,5], South Africa has, therefore, placed renewed urgency on PHC and DHS development [6-8].

International experience shows that re-orienting health systems towards PHC challenges existing ways of working [4,9]. In South Africa, dispersed accountability, complex rules and procedures, and an organizational culture of deference to hierarchy within it also “*overwhelm rational policy debate and the implementation of new policy*” [10]. As a result, and as pointed out by the National Department of Health, the South African health system remains strongly hospital-centric and specialized, with decision-making driven more by service than population needs [6]. As elsewhere, the pro-active pursuit of population health needs and equity goals in PHC strengthening requires, therefore, fundamental changes in the way health system actors think and work, in its organizational culture, supported by new forms of health system leadership [11,12]. Although there is only limited evidence about what such leadership entails, theoretical perspectives suggest that ‘reculturing an organisation’ involves empowering front line workers to think and work differently by encouraging subtle change in the values, customs, relationships, and conversations shaping their behaviour [13-15].

In this paper, we present experience to illuminate both the challenges that confront efforts to strengthen PHC within the South African health system, and the nature of leadership needed to mediate such organizational change. Our analysis is framed by the concepts of sense-making and discretionary power, drawn from theory on complex adaptive systems and policy implementation, respectively. We argue that, to become a lived reality within the DHS, those working to support primary and community-based services, including PHC facility

managers and their staff, must be able to make sense of PHC-promoting policies and plans, and incorporate them into their everyday routines and practices. This requires new forms of leadership by the health system’s middle managers, namely sub-district managers: a leadership of sensemaking in support of PHC strengthening.

We are a team of health system managers and researchers working together to understand and act in the district health system, through cycles of collaborative action and learning, in Mitchell’s Plain health sub-district, Cape Town, South Africa. Our analysis represents a theoretically-framed reading of one particular set of experiences in one particular place, generated through a careful, systematic, and reflective research collaboration. We do not seek to derive discrete policy lessons about particular activities that can strengthen PHC in South Africa or elsewhere. Instead, recognizing policy learning as an organic process [16], our intention is to stimulate those working in other settings to think differently about the forms of leadership needed to sustain PHC.

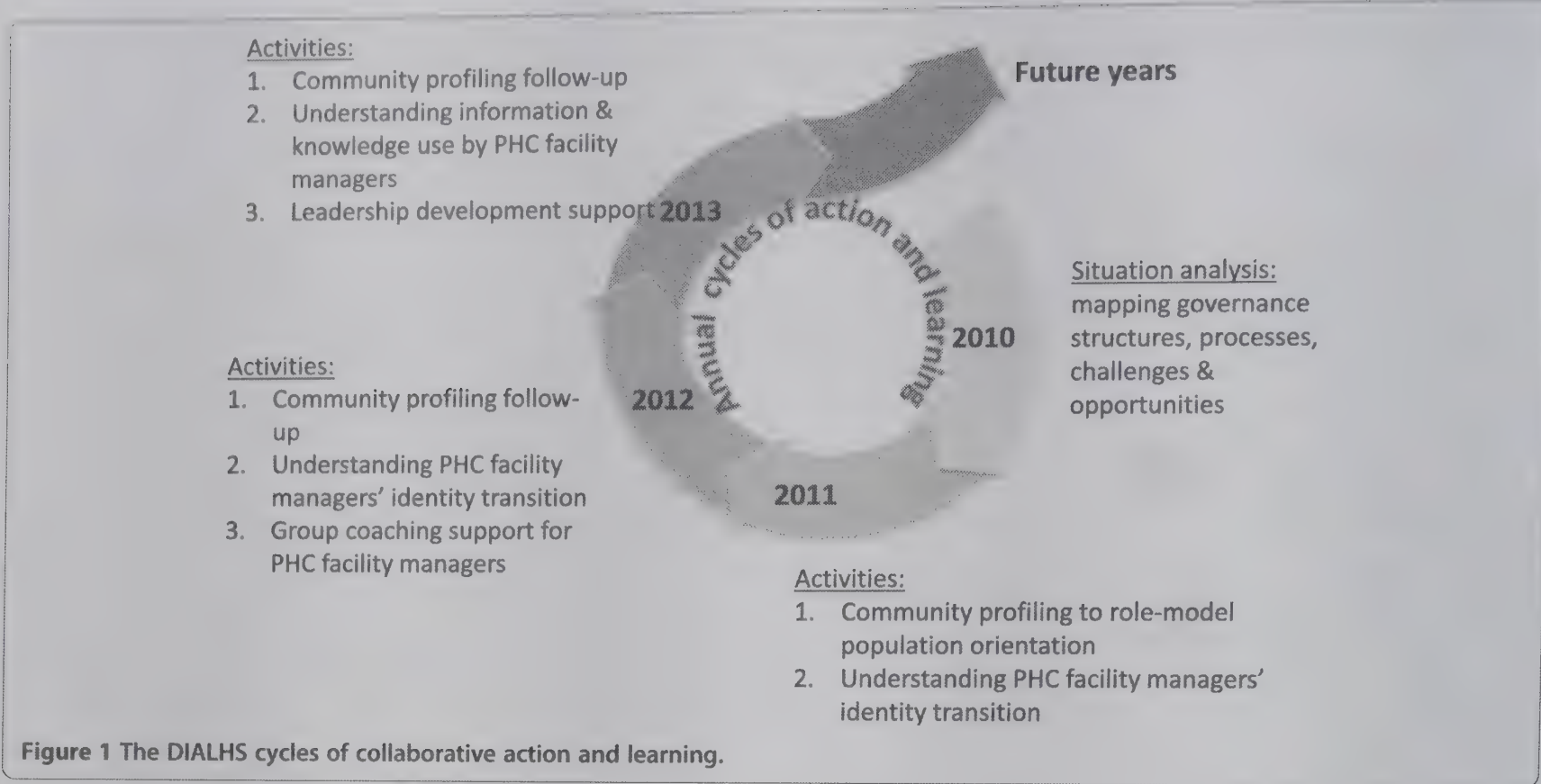
Methods

Study approach and focus, data collection, and data analysis

The experiences we present are drawn from the District Innovation and Action Learning for Health Systems Development (DIALHS) project, initiated in 2010 as a service-research partnership focused on governance issues within the Mitchell’s Plain health sub-district, Cape Town. It involves collaboration between two health authorities (the City of Cape Town and the provincial health department of the Western Cape government), and two universities (the Universities of Cape Town and the Western Cape).

We began our engagement by conducting a situation analysis to understand the managerial structures and processes of the sub-district and its location in broader district functioning. Discussion of this analysis then led us to consider further how sub-district managers can better support PHC facility managers to lead their staff teams. As Figure 1 indicates, we have subsequently addressed this concern through iterative cycles of collaborative action and learning [17,18], including a focus on facility managers’ experience, that have entailed cycles of data collection, analysis, and interpretation. Reflective practice has been a common approach in all our activities, and is itself an intervention in managerial practice [19].

Table 1 outlines the range of data generated across our activities, which include transcripts and notes of general reflective discussions within the research team, and with managers. This paper is based specifically on the internal report of the initial situation analysis (2010), notes of key DIALHS discussions within sub-district management



meetings (2010–2012), researcher field notes (2010–2012), transcripts and notes of 22 interviews and personal meetings with managers at district and sub-district level (2010–2013), and transcripts of 5 research team reflective discussions (2011–2012). Following the principles of thematic analysis, these data were initially systematically reviewed with our conceptual starting points in mind (see below), by the researcher-authors (LG, UL). An initial

synthesis and narrative of experience was then developed for discussion with the other authors, the two primary sub-district managers (SE, PO), in a validation process equivalent to member and peer-checking that also generated further insights drawn into the final paper. Therefore, in our work, we have been systematic, a core criterion of validity in action learning [17], as in other research [20]. We have also allowed double-loop learning [21],

Table 1 Data generated within DIAHLS project 2010–2013

Activities and engagements which generated data		Data generated
Situational analysis		Review of policy documents and minutes of statutory meetings Stakeholder interviews Observations of meetings
Cycles of	Planning interventions	Presentations and meeting/workshop notes; document reviews Composite reports
	Community profiling and local area groups	
	Support for environmental health practitioners	
	Support for PHC facility managers	
	HIV/AIDS & TB programme roles	Presentations, notes of meetings, field notes, and reports Notes of meetings with teams involved in intervention Presentations and reports to ISDMT meetings
	Implementing of interventions	
	Review and reflection	
Research sub-studies		
The transition process from nurse to facility manager		Interviews
The information used by facility managers in routine decision-making		Observations
Meetings and reflections of research team		Transcriptions and notes of reflective meetings of research team
Interviews and reflective conversations with sub-district and district managers		Notes of meetings with district managers Notes of meetings with sub-district managers

deepening understanding of experience through reflection during our work and in developing this paper – stepping back from the initial narrative, interrogating our assumptions, and viewing it from different perspectives.

Our work has ethical clearance from the Human Research Ethics Committee of the Faculty of Health Sciences, University of Cape Town (Ref 039/2010), and research approval from both the City of Cape Town and Western Cape Provincial Government Department of Health.

Conceptual foundations

Sensemaking can be understood as *“the process individuals undertake as they try to understand what is going on around them, as they try to make sense of events and experiences”* [22]. In sensemaking, our mental models, that is our beliefs and assumptions about how the world works [23,24], help us to notice phenomena in our environment, which we then categorise and label, making meaning of them, ultimately as a basis for acting. Sensemaking is, therefore, about the interplay of interpretation and action [25-27].

The adaptive agents within complex adaptive systems (CAS) are sensemakers, whose interpretations of their world are shaped by the system paradigm, the underpinning, often unspoken but shared, social agreements about the nature of reality in that system [23]. Because agents in every system are interconnected and interdependent, their many daily interactions also result in the emergence of shared ways of being and doing, patterns of collective behaviour that are taken for granted [28]. These system structures, the manner in which a system's elements are organized, include, for example, practices of inter-personal engagement and information flows; they, in turn, shape the patterns of organizational life that generate the events that we most easily notice [24].

Although not recognized as CAS theory, Lipsky's [29,30] theory of Street Level Bureaucracy (SLB) illuminates CAS ideas with specific reference to public policy implementation. The discretionary power of 'street level', or front line, workers in public bureaucracies exists because they are *“free to make a choice among possible courses of action and inaction”* [31] within the rules shaping their behaviour, allowing them to translate policy through their practices and interactions with clients. Lipsky argued that as they interpret, choose, and act, they are guided by the mental models they develop to manage their demanding work settings characterized by heavy workloads, resource constraints, and centrally directed and often unclear, policy imperatives. In these settings the unanticipated consequences of the ways they manage their time and engage with their clients include limiting access to public services and treating clients

disrespectfully. However, front line workers can also engage positively with clients, particularly when encouraged to use their discretionary power to be responsive to clients [32].

These bodies of theory both suggest that hierarchical, command, and control leadership practices do not take account of the reality of complex adaptive systems and policy implementation. SLB theory specifically notes that top-down action to control the use of discretionary power will only encourage front line workers to stereotype and disregard client needs [29]. The sensemaking literature suggests, moreover, that during times of organizational change individuals try to make sense of their experience by engaging with others, generating shared interpretations that, in turn, shape their behaviours and trigger further sensemaking. This cycle generates new, shared ways of working that may not be aligned with the intentions of new initiatives [26]. The theory suggests, therefore, that particular forms of leadership are required to implement policy and bring about organizational change in CAS. Such leadership needs to be distributed across all levels of an organization, placing particular demands on middle-level managers [33]. Moreover, as *“real leverage exists deep in the recesses of the systems – mind-sets, values, beliefs – where identity is created”* [28], such leadership needs to mediate sensemaking and support changes in the shared assumptions about how people should act (so influencing their exercise their discretionary power) in different situations [23,24].

Results

Drawing on our conceptual foundations we now present experience from a health sub-district in Cape Town, considering both sensemaking and exercises of discretionary power, and leadership practices that seek to recognize both in supporting new ways of working. We start by describing the setting of our work.

Mitchell's Plain health sub-district

In 1976, residents from 250 different communities across Cape Town were forcibly removed and settled in Mitchell's Plain, when it was designated a 'separate' area for so-called 'coloured people'. This birth in violent social dislocation reverberates to this day, and it is now one of the poorest areas of the city. High unemployment and low labour absorption (at 24% and 46%, respectively, according to the 2011 census) [34], as well as substance abuse and poor schooling, exacerbated by massive population growth, contribute to vicious cycles of poverty, crime, and social destabilization.

Public PHC services in Mitchell's Plain health sub-district are provided to a population of over 510,000 (2011/2012) by both local and provincial government facilities focused, respectively, on preventive, promotive,

and curative child health services, and adult curative care.^a Indicators point to a relatively strong public health service performance in the sub-district: a tuberculosis (TB) cure rate of 88%, immunization coverage at 93%, and 56% of ante-natal care visits occurring before 20 weeks. However, there are still numerous underserved communities, particularly in the newer, fast developing areas of the sub-district; and there are regular patient complaints about poor quality of care and areas of service delivery weakness. Key health problems include a co-infection rate of TB and HIV of 50%, non-communicable diseases, mental ill-health, and violence ([35], and data from 2011/2012 District Health Expenditure Review for Cape Town).

Efforts to integrate and strengthen PHC service provision across the two health authorities over the last 20 years have been complicated and hampered by a range of legal, labour, and financial obstacles. The 2008 establishment of the Metro District Health System (MDHS), as part of the provincial government's wider vision of strengthening PHC,^b provided the structural platform for delivering comprehensive and integrated PHC services in Cape Town. At present, the Mitchell's Plain integrated sub-district management team (ISDMT) coordinates service delivery in agreed areas between local (City of Cape Town, CoCT) and provincial government (MDHS).

The two Mitchell's Plain health managers were appointed to their current posts in 2005 (SE, CoCT sub-district manager) and 2012 (PO, MDHS sub-structure manager). Their position within the complex lines of authority that make up the Cape Town health system is shown in Figure 2. Located at the interface between top-down strategic planning processes and bottom-up operational decision-making processes and action, they are the middle managers [36] tasked with leading the establishment of a health system oriented towards population health needs as envisioned by provincial health policy (manager interview notes, 1 July 2010). Working within centrally-set budget limits and human resource management guidelines, they both have some decision-making latitude. Overall, they are responsible for the management of resources, people and perceptions (manager interview notes, 19th July 2010), and judge that their biggest challenges lie in managing people and their perceptions [35].

The sub-district health managers see PHC facility managers as key players in strengthening PHC in Mitchell's Plain. These managers and their staff represent the face of the health system to the public, are responsible for its responsiveness to people and patients, and should be among the first to pick up community health needs and concerns.

Mind-set challenges to PHC in Mitchell's Plain

Over the last 20 years, PHC in Mitchell's Plain has become "a more complex environment for those working in

and for the community. Nurses see a lot of sick children and sometimes the children die. Nurses don't all necessarily have the right skills (for these situations, and given high staff turnover). So facility managers have to manage this complexity and also don't all have the skills. And they have little confidence in the system – for example, ambulance services don't arrive on time. And the managers don't know how to talk to the community for example over deaths in facilities, or how to help staff cope with the demands" (Manager interview notes, 13th April 2012).

In this environment, there is a duality of sensemaking and action. As a group, front line staff often seem to end up working against PHC-oriented change, even though as individuals they might support its goals. Facility managers and their staff commonly maintain collective mind-sets that are steeped in the autocratic and procedural cultures of a previous era and that run counter to a population health and PHC orientation. The sub-district managers note that some staff display rather "authoritarian and autocratic attitudes towards patients, and do not want to share power with them" (ISDMT notes, 19th Jan 2011). They also think that facility managers do not always "understand the 'big picture' of facility services, that is, the health needs of the population they serve, the challenges patients face in accessing services, and so the importance of new community-based activities and programmes. They don't generate and use information to understand the needs of the population they serve, and 'they don't think beyond the people coming into the facility'" (Researcher field notes, 6th July 2012). Indeed, as the PHC facility managers are all professional nurses by training and receive limited support when first appointed, many of them prefer, and even feel more confident, in their clinical rather than managerial roles [37].

Often, facility managers also seem to work in a very procedural way – adopting an attitude that says, "I want the piece of paper that tells me how to act" (Research team notes, 14th December 2010). Whilst recognizing that these managers are mostly quite capable and competent, sub-district managers often see them as having an "external locus of control" –being too passive, not persistent in dealing with problems in their facilities, including complaints from patients, or in keeping track of their own performance (Manager interview notes, various dates; Research meeting notes, 4th December 2012). Timekeeping and keeping up with routine schedules of activities is also judged to be poor. When given new decision-making authority, facility managers appear to respond fearfully rather than by embracing the opportunity: it seems as if "they don't take responsibility for new activities or actions to improve services. They say to their staff, 'the sub-district manager said you must do it', rather than projecting a positive image of the activity

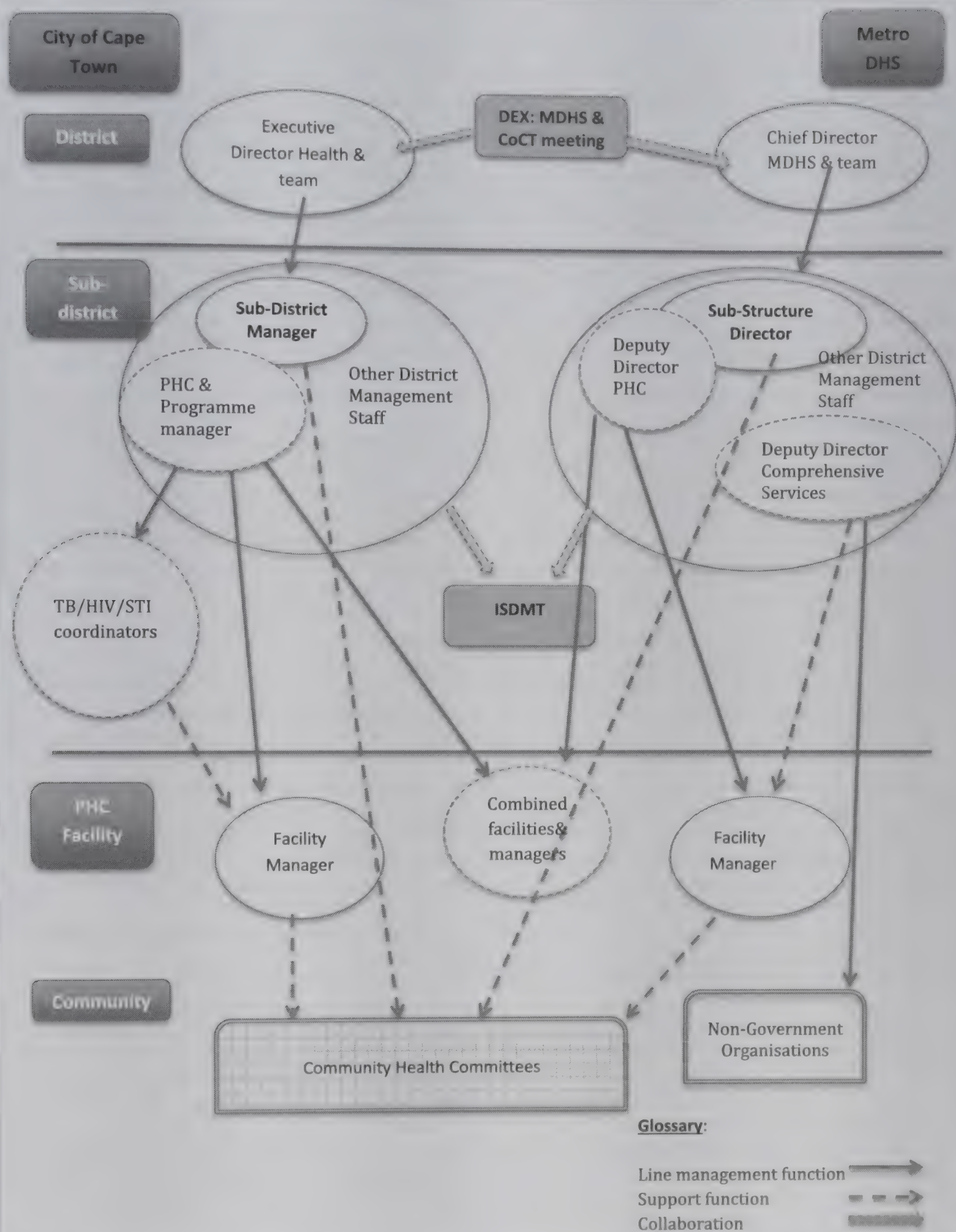


Figure 2 Lines of authority in the Cape Town Metropolitan Health District [adapted from [35]].

and owning it" (Researcher field notes, 6th July 2012). Such resistance is typical of the exercise of discretionary power by street level bureaucrats [29], but also reflects 'change fatigue' [38-40] and organizational uncertainty after nearly 20 years of constant health system change. The continuing debates about if, when, and how local and provincial government PHC services will be integrated in Cape Town have only aggravated this uncertainty.

The retention of paternalistic and autocratic approaches is, moreover, not restricted to frontline workers. Staff survey results indicate that communication practices are commonly perceived to be quite hierarchical in the wider health system [41]. Some sub-district managers even talk about PHC facility managers as "their children", expressing the need "to watch over them" (Research meeting notes, 4th December 2012). An 'ambivalence towards authority' among South Africa civil servants is, moreover, a general apartheid legacy [42] that is compounded, within the health system, by "the accumulated weight of existing practices and procedures, together with embedded hierarchies that institutionalise a specific distribution of power and privilege" [10].

Sensemaking and resistance to centrally-led PHC improvement targets

In strengthening PHC, the experience around annual targets provides an important example of how sensemaking plays out, given dominant mind-sets. In line with provincial and local government health plans, annual targets are centrally established within strategic planning processes to drive PHC service improvements in Cape Town (e.g., for tuberculosis cure rates or extension of basic ante-natal care across facilities). These targets are backed up by regular monitoring through 'plan, do, review' (PDR) meetings where managers at different levels come together to examine facility, sub-district and district performance against targets, identify challenges and develop actions to address them.

Mid and senior health managers see these processes as "providing standardized frameworks to guide lower level managers and, more specifically, providers, to work differently to better meet population health needs" (Manager interview notes, 19th July 2010). They also argue that "policy provides a stable structure within which people know what is expected of them" (Manager interview notes, 13th April 2012) and that standardization higher up the system is "to give some predictability/logic to allow for innovation lower down... to bring the certainty needed for innovation lower down the system" (Manager interview notes, 19th July 2010).

However, both positive and negative meanings have become attached to the word 'targets' in the Mitchell's Plain health system discourse. The positive potential is expressed as "directing people towards common goals, or giving people a motivating force". Reaching a target can,

thus, bring a sense of achievement and positive energy (Research meeting notes, 4th December 2012). In contrast, the dominant language PHC facility managers and staff use around targets is quite negative – with targets seen as disempowering, as a disciplinary tool, and as encouraging or enabling micro-management by higher-level managers. Perhaps refracted through the prism of history and wider organizational culture, facility managers seem to understand the word 'targets' as authoritarian and therefore illegitimate: "It's all that is bad in the system... it also says 'we don't have agency'... 'we are bombarded, can't do anything else', so it removes accountability and responsibility for anything other than the target" and so "a lot of the target conversation is completely disembodied, it's removed from the actual meeting of service needs" (Research meeting notes, 5th December 2012).

Given the prevailing mental models, targets and the PDR processes are, in a sense, filtered through a power battle between managers seeking to give clear and consistent direction for strengthening PHC to multiple actors, and front line staff, shaped by histories and cultures of passivity and dominance, resisting change and afraid to take on new responsibilities. Although facility managers mostly comply with reporting requirements, they have not yet adopted the broader problem-solving attitude or willingness to take ownership of, and make effective, efforts to improve PHC services. As noted in other settings [29,43], central efforts, such as target setting, that seek both to contain the discretionary power of street level bureaucrats and direct it towards imposed goals often have unexpected consequences. Planned (imposed) change may encourage compliance without conviction [44], because, as sensemaking theory notes, it fails to provide spaces for the new forms of sensemaking necessary to support the intended changes [26]. Ultimately, therefore "change is itself an interpretive process" in which "[t]he meaning of top down initiatives emerges bottom up" [33].

Supporting PHC strengthening through a 'leadership of sensemaking'

From our first engagements, sub-district managers recognized the challenge of having to address the passivity of PHC facility managers and their staff, and their role in empowering them "to work differently to meet needs", as critical issues in Mitchell's Plain (Manager interview notes, 19th July 2010). Within the DIALHS collaboration we have subsequently, in a mixture of deliberate and spontaneous actions, tried out different ways of engaging and supporting PHC facility managers to recognize and address population health needs, working with their staff. Our initiatives include both new, joint activities (e.g., the community profiling initiative) and adaptations to routine processes and practices (e.g., the key performance area (KPA) process). All seek to encourage PHC facility managers to take ownership

of their own performance, and that of their staff, as well as to hold them to account for it (Manager interview notes, 15th Oct 2012; 7th December 2012; 9th April 2013).

The community profiling initiative (generating local knowledge, priorities, and action through multi-actor engagements)

In early 2011, we initiated an activity that aimed to strengthen three inter-related planning and management priorities in the sub-district: i) 'shifting the lens' of service providers from a patient to a stronger population orientation in health system organization and functioning as advocated by provincial and national policy guidelines; ii) moving the sub-district's thinking and visioning beyond one-year planning cycles; and iii) strengthening relationships between service providers and community representatives.

Provincial and district management had recently emphasized the need to address health of populations, rather than patients alone, in their policy and planning guidelines. Yet, facility managers had repeatedly expressed uncertainty and frustration with the fact that they "did not know the communities they were serving", did not know how to engage with other role players or access other health resources in communities, and were overwhelmed with the need to service short-term targets instead of being responsive to local priorities and needs.

A series of larger and smaller workshops brought together multiple stakeholders from health authorities and civil society to identify and map health resources and gaps, as well as to identify appropriate local action and planning priorities to address the gaps and challenges.

These activities succeeded in overcoming or at least lowering perceived barriers between different groups and brought actors into conversation with each other, drew on their shared informal knowledge of local health contexts, and provided opportunities to generate shared meanings about those contexts.

These 'conversations' have subsequently led to some specific health initiatives, such as continued action to share knowledge among groups and tackle environment health problems in certain communities. However, maintaining local area groups in all areas in the sub-district has proved difficult.

The local government PHC facility manager 'KPA process' (developing local service improvement priorities)

In 2010, the local government sub-district health manager introduced a new process to encourage pro-active planning and action by facility managers,

involving: i) setting clear, locally appropriate objectives within the broad priorities specified in established health plans; ii) outlining activities, intended outcomes and monitoring and evaluation approaches; and iii) holding facility managers to account for implementing agreed actions.

Working with support, facility managers each developed their own KPAs and then presented them to the whole sub-district managerial team in late 2010. During the course of 2011 they periodically reported back on progress in implementing agreed actions and in late 2011 developed a new set of KPAs for 2012. In parallel, the routine PDR meeting between facility managers and their line managers in which facility challenges are discussed, was re-named and re-structured to allow a stronger regular focus on collectively considering how to address common PHC facility challenges, including sharing 'best practices' and success stories among these managers. Using existing language and the KPA terminology to introduce the new process, the sub-district manager, nonetheless, reframed this language to emphasize its developmental and sense-giving potential. She also role-modelled constructive accountability through creating a space to allow collective consideration of challenges and successes.

After two years, implementation is uneven, as follow-up and consistent documentation have been lacking. While some managers easily saw and acted on the opportunity to self-determine priorities, others will need more support to gain the confidence and skills to identify and act on local priorities.

Reflecting on our activities through theoretical lenses throws light on five possible elements of a 'leadership of sensemaking' for PHC strengthening. The importance of middle managers' personal values as a foundation for other leadership action is the first element [14]. Leadership values and capabilities of particular relevance to sensemaking for PHC might include concern for the population being served and the broader social determinants of health; recognizing the potential in other people, for example by adopting a mentoring approach towards other staff; and being reflective and self-critical – willing to learn and change one's own practices (Manager interview notes, 13th April 2012; 9th April 2013; 20th May 2013).

From this foundation, we have applied four other cross-cutting leadership practices in supporting PHC facility managers:

- i. Nurturing the values and moral purpose of PHC staff
- ii. Building relationships to support the development of shared meanings about change

- iii. Instilling a culture of collective inquiry and mutual accountability within the sub-district
- iv. Role modelling critical management practices and using language to signal new meanings

First, nurturing the values and moral purpose of PHC staff – encouraging facility managers, for example, ‘to dream’ about working differently (ISDMT meeting notes, 20th October 2010).

Re-orienting front line health staff towards a population health focus, encouraging them to take a pro-active role in managing services to meet community need, requires a *“real mind-shift for managers and staff”*. *“A community orientation has to become part of people’s way of being”* (ISDMT meeting notes, 19th Jan 2011), but some facility managers and staff do not currently have, and even resist, this orientation. The sub-district managers, therefore, constantly and consistently affirm the importance of patients and the broader population in all their engagements with staff – for example, encouraging facility managers to align broader goals and targets with local priorities, or to respond speedily to patient complaints.

Within the DIALHS collaboration, we also, more formally, initiated a collaborative community engagement process in 2011 to encourage conversation about local health needs and resources among different stakeholders in the sub-district (see Community profiling initiative). We expressly framed this activity within the context of the social determinants of health and allowed facility managers to think about the world outside their facilities. In implementing this process, sub-district managers noted that it was important to role model new mind-sets and use new language: *“whoever looks at us needs to know that as a team we are committed to the DHS and PHC, and building it with a population focus and orientation– and this is what we are working towards, this is what DIAHLS is supporting... It needs the full support of the ISDMT, every member needs to really believe in the process, to understand it and be committed to it. They need to talk positively about it when talking to facility managers and other staff, they need to take roles in making it happen and really support it.”* (ISDMT meeting notes, 19th Jan 2011).

The importance of such an approach is only affirmed by theory. *“Leaders must foster learning and values... They need a sense of optimism that can help the system deal with complexity, risk taking, and uncertainty. They need to help the system maintain a coherent identity”* [28]. Shared values and visions may, moreover, act as catalysts of change within a CAS, especially when they emerge through experience, providing the common energy that encourages and enables commitment to action across people within a system [14].

Second, in line with wider thinking [14], we have created spaces and processes where facility managers can be brought into relationship with each other, with colleagues in the sub-district and with other local actors, to share knowledge and ideas, challenge each other and learn from each other. The community profiling initiative, for example, initially comprised a process of sharing ideas and experience in drawing onto physical maps. Facility managers commented on the value of seeing the world through others’ eyes, realizing also how knowledgeable community members are, and on having opportunities to talk with other local actors outside the pressurized atmosphere of their facilities.

Several of the routine sub-district meetings have, furthermore, been adapted to provide opportunities to share and discuss experience about achievements, challenges, and priorities and to give space to developing team working among facility managers and with sub-district colleagues responsible for human resource management, supply management, and information systems. Meeting spaces also provide opportunities to develop new forms of accountability, to move away from the top-down approach perceived as checking progress towards targets and disciplining failure, towards a shared engagement about what enables and prevents progress, developing collective responses to tackling challenges: *“it’s not about holding people accountable, but providing a space to be supportive in holding them accountable”* (Researcher field notes, 6th June 2012; see also Key performance area process).

Within DIAHLS, we have also thought quite carefully about meeting practices that allow more active engagement and ownership by all those present, rather than primarily being spaces where information or instructions are transmitted from managers to staff. Rotating the task of chairing, using rounds to allow each person to make an input to the meeting, and asking challenging questions are, for example, ways of demonstrating equality, rather than reinforcing existing bureaucratic power balances, and of sharing experience to identify where support is needed. *“The basic assumption is that opening up the meetings in these ways makes them less intimidating or threatening, and allows better communication – a two-way flow of ideas, between sub-district and facility managers in particular, but also to contextualize information about new activities for other programmes and support staff, and so encourage greater understanding and ownership of the activities”* (Researcher field notes, 6th June 2012).

Third, through meetings and other routine activities the sub-district managers are also trying to instil a new culture of reflection and questioning – trying to encourage facility managers to ask ‘does it make sense, how must it be done, can it be done better?’ As one manager

argued, “We have to change the way we do things, and that means not accepting how things currently are.” (Manager interview notes, 13th April 2012).

The ‘KPA process’, for example, specifically sought to respond to the negative perceptions around target setting by providing a space to allow facility managers to identify their own priorities whilst working within existing planning frameworks and job descriptions. The intentions were to encourage understanding of higher level strategic priorities, forward planning at facility level, engagement with data relevant in setting priorities, and to develop “*an attitude which looks at the underlying causes of challenges so that you can actually get to the systemic issues you need to change to improve the whole picture*” (Researcher field notes, 19th July 2012).

Finally, sub-district managers are role modelling more systematic approaches to management through their personal practices [22]. For example, in how they conduct staff appraisal discussions, being available on time for meetings and being respectful in their treatment of colleagues, as well as by coaching staff, running staff workshops in ‘difficult’ facilities and providing hands on support to weaker managers (Manager interview notes, 1st April 2011; 15th October 2012; 7th December 2012). The research team members have, meanwhile, sought to role model reflective practice through their research approach, for example, and in their approach to managing meetings.

We also all recognize the power of language, through which managers are “*able to articulate meanings, lend weight to collective action, and clarify the hoped for image of the organisation*” [45]. The quarterly PDR meeting for local government facility managers, for example, has been deliberately renamed the Management and Communication meeting as a response to the sense that the managers “*felt the name of the ‘PDR’ led people to worry, as they understood it to be essentially about criticizing them for not reaching their targets*” (Researcher field notes, 6th June 2012).

Ultimately, through these various practices, the sub-district managers are seeking “*to use the intangible in combination with the tangible in ways that keep an eye on the goal [of PHC], but do things a bit differently – that’s bottom up power*” (Research meeting notes, 5th December 2012).

Discussion

These Mitchell’s Plain experiences show how, despite individuals’ agreement with overall policy goals, efforts to strengthen PHC confront facility managers’ collective weakness to engage in pro-active, local-level problem solving in support of population health and equity goals. This reluctance reflects collective mind-sets of passivity and risk avoidance rooted in three key experiences:

authoritarian cultures and histories; nearly two decades of centrally-driven policy and organisational change; and growing complexity in patient demands. These experiences, in turn, underpin vicious cycles of passivity, resistance to change, and further passivity, illuminating the ways in which, as Lipsky foresaw [29], sensemaking and the exercise of discretionary power are intertwined.

The experiences also suggest that beyond developing guiding visions about PHC strengthening, leadership for PHC must support facility managers to take ownership of these visions collectively. The visions must make sense to them if they are to incorporate them into their practices and so exercise their discretionary power in pursuit of PHC goals. Lipsky [29] identified, for example, the importance of supporting front line workers through “*ongoing processes of supportive criticism and inquiry. Built into every week of practice should be opportunities to review individual’s work, share criticisms, and seek a collective capacity to improve performance*”. CAS theory, meanwhile, notes that, to support system change, leaders must create the conditions for the emergence of such change – in particular, by encouraging the cycles of action, feedback and learning that empower system actors to think and work differently [45].

Mitchell’s Plain sub-district managers have, partly in collaboration with researchers within the DIAHLS project, initiated various activities intended to provide spaces of collective sensemaking to empower facility managers in these ways. Although these sensemaking efforts are still in their early days, the overall approach is affirmed by wider theory and empirical experience in two ways. First, in this broader literature, middle managers are recognized to play important and very particular roles as change intermediaries in organisational sensemaking, because they are positioned at the interface between an organisation’s senior managers and front line employees [36]. From this position, “*...interpretation is a key role. They need to ‘make sense’ upwards with senior managers, and laterally with peers and downwards with teams, to aid their interpretation of change intent and negotiate how change should be taken forwards*” [25,33,46]. Second, to support organizational sensemaking, the literature suggests that middle managers must reflect on their own perspectives and behaviours, thinking about how they will help others through change. They will need to create spaces for conversation, reflection, and dialogue, perhaps around planning, resource allocation, and monitoring processes – allowing colleagues to revisit their own mental models, understand those of others, and develop shared interpretations and meanings of change [25,28,29]. More concretely, and directly reflecting Mitchell’s Plain experience, the ‘Leadership to support implementation of nurse-led community health programmes’ section below outlines the leadership practices applied within a UK experience of

organisational change around nurse-led community health programmes [47,48].

Leadership to support implementation of nurse-led community health programmes [Source: 47]

- Created conditions for change through reflection, debate and challenge, workshops, skills audits, and education programmes.
- Action learning to facilitate understanding of mental models and enable challenge to those models, leading to modification.
- Worked with the 'strange attractors' (experiences or forces that attract the energies and commitment) that motivated practitioners (individual clients for some, whole communities for others).
- Introduced new relationships that led to new ideas, emergent behaviours, and work patterns.
- Held multiple participatory events to encourage involvement, collaboration, and self-organisation.
- Established a few clear rules through discussion.

Nonetheless, we recognize that the sensemaking activities we have initiated will, inevitably, unfold in unpredictable ways over time. We do not expect that they will generate immediate and obvious change in sub-district performance, and instead we seek to encourage some change in meanings and practices that we hope will, over the longer-term, help embed a population health orientation within the local health system. Such leadership recognizes that *"the order in organizational life comes just as much from the subtle, the small, the relational, the oral, the particular and the momentary as from the conspicuous, the large, the substantive, the written, the general and the sustained"* [26].

Some indications of the positive potential of our sensemaking work lie in the perceptions of managers outside the sub-district. They report seeing a difference in the way things work in Mitchell's Plain, in the willingness of staff to work together and tackle problems, and that they see the results in implementation of service delivery improvements. Inside the sub-district, some facility managers also report finding the KPA process helpful as it provided a sort of on-the-job training and supported local level decision making to tackle problems. There are also clear indications of stronger peer support among facility managers.

However, our experience only confirms another theoretical insight – that it takes significant energy and attention to prevent personal and system practices falling back into pre-established patterns [26]. Maintaining energy around the local area groups that developed through the community profiling, for example, has been a challenge, and facility managers have become dis-engaged from the activity

(see *Community profiling initiative* above). Staff turnover also represents a significant challenge to institutionalizing new practices and meanings: for example, whilst the KPA process (see *Key performance area process* above) had some impact on some of those involved, newly appointed facility managers did not receive much orientation or support for their engagement in this process and so were not really sure what they were doing.

For middle managers, meanwhile, the Mitchell's Plain experience indicates that the challenges of leadership include the ways in which their sensemaking efforts are filtered through other colleagues who may not adopt similar approaches or who may themselves be threatened by new approaches and ideas. In the face of facility managers' apparent passivity and lack of confidence, it may also be easy to slip back into micro-management; and, in the face of external demands, it is hard to maintain positive role modelling. To support organizational change middle managers not only need negotiation, persuasion and advocacy skills, but also, support from higher-level managers – such as the time and flexibility to sustain sensemaking engagement with those on the front line of organizational change/policy implementation [22,36,46], consistent and positive messages about new activities from higher levels of the system, and a willingness to allow experimentation to fine tune these activities.

Conclusions

Although exploratory, this analysis adds to the still limited body of work examining health system complexity [49], the influence of actors over policy implementation [50], and the leadership needed to support system-wide reforms in pursuit of population health and equity goals [12]. Indeed, we believe that this is the first paper specifically to begin to consider how sensemaking and discretionary power work together in challenging or supporting PHC re-orientation within a middle-income country health system, or to consider what a leadership of sensemaking for PHC entails. It has been made possible by the long-term and collaborative nature of the DIAHLS project, which supports the co-production of knowledge about the inner workings of the Mitchell's Plain health system. Building on experience so far, we will continue to work together to strengthen, and track over time, our efforts to support PHC performance improvement.

Our core argument is that:

- i. The system-wide population health re-orientation needed to sustain PHC in South Africa will only become a lived reality when the front line staff who work at the health system's interface with the population bring it alive within their everyday routines and practices;
- ii. These agents' sensemaking capabilities mean centrally-directed initiatives intended to strengthen

PHC are re-interpreted as implemented, with unexpected consequences that can include resistance to centrally-led activities (i.e., exercising their discretionary power in ways that thwart such initiatives);

- iii. New forms of middle manager (and wider) leadership are required to nurture collective sensemaking around PHC goals and empower front line health staff to take ownership of these goals, and so exercise their discretionary power in their pursuit;
- iv. Mind-set changes, focused on concern for the population being served, the broader social determinants of health, and a willingness to act, are likely to be the fundamental basis for strengthening and sustaining PHC.

In a complex adaptive system “...organisational change is not management induced. Instead, organizational change is emergent change laid down by choices made on the front line” [26]. Nurturing such change at the front line of the health system requires, therefore, new forms of leadership that enable sensemaking in support of change and unleash the collective power distributed across the system towards shared goals.

Endnotes

^aThe sub district population is around 510,000 and so is large in comparison to the WHO definition of a health district. In South Africa, the nine provinces each have constitutional authority for managing health services in their area and implementing health policy, with local governments having concurrent responsibility for managing aspects of primary health care.

^bSince 1994, structural, management, and service delivery developments within the Western Cape province health system have been guided by three inter-linked health policy documents: the 1995 *Provincial Health Plan*, the 2005 *Comprehensive Service Plan* (2005), and, most recently, the *Healthcare 2030* policy document (available at <http://www.westerncape.gov.za>). Working within national policy frameworks, they provide a guiding vision for organizational change of a health system oriented towards population health needs and founded on a strong district health system.

Abbreviations

CAS: Complex adaptive systems; CoCT: City of Cape Town; DHS: District health system; DIALHS: District Innovation and Action Learning for Health System Development; ISDMT: Integrated sub-district team; KPA: Key performance area; MDHS: Metro District Health System; PDR: Plan, do, review; PHC: Primary health care; SLB: Street level bureaucracy; TB: Tuberculosis.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

LG co-led the conceptualization of the paper and related data analysis, wrote the first draft of the paper, and revised it with comments from other authors. SE contributed to the paper's conceptualization and data analysis, and commented on drafts of the paper. PO contributed to the paper's conceptualization and data analysis, and commented on drafts of the paper. UL co-led the conceptualization of the paper and related data analysis, contributed to the first draft of the paper and commented on subsequent drafts. All authors read and approved the final manuscript.

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RESEARCH

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Advancing the application of systems thinking in health: advice seeking behavior among primary health care physicians in Pakistan

Asmat U Malik^{1*}, Cameron D Willis², Saima Hamid³, Anar Ulikpan⁴ and Peter S Hill⁴

Abstract

Background: Using measles and tuberculosis as case examples, with a systems thinking approach, this study examines the human advice-seeking behavior of primary health care (PHC) physicians in a rural district of Pakistan. This study analyzes the degree to which the existing PHC system supports their access to human advice, and explores in what ways this system might be strengthened to better meet provider needs.

Methods: The study was conducted in a rural district of Pakistan and, with a cross-sectional study design, it employed a range of research methods, namely extensive document review for mapping existing information systems, social network analysis of physicians' advice-seeking practice, and key stakeholder interviews for an in-depth understanding of the experience of physicians. Illustrations were prepared for information flow mechanism, sociographs were generated for analyzing social networks, and content analysis of qualitative findings was carried out for in-depth interpretation of underlying meanings.

Results: The findings of this study reveal that non-availability of competent supervisory staff, a focus on improving performance indicators rather than clinical guidance, and a lack of a functional referral system have collectively created an environment in which PHC physicians have developed their own strategies to overcome these constraints. They are well aware of the human expertise available within and outside the district. However, their advice-seeking behavior was dependent upon existence of informal social interaction with the senior specialists. Despite the limitations of the system, the physicians proactively used their professional linkages to seek advice and also to refer patients to the referral center based on their experience and the facilities that they trusted.

Conclusions: The absence of functional referral systems, limited effective linkages between PHC and higher levels of care, and a focus on programmatic targets rather than clinical care have each contributed to the isolation of physicians and reactive information seeking behavior. The study findings underscore the need for a functional information system comprising context sensitive knowledge management and translation opportunities for physicians working in PHC centers. Such an information system needs to link people and resources in ways that transcend geography and discipline, and that builds on existing expertise, interpersonal relationships, and trust.

Keywords: Health system, Measles, Pakistan, Primary health care, Social network analysis, Systems thinking, Tuberculosis

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Background

Access to information is critical for creating and maintaining high performing primary health care (PHC) systems [1]. This aspect becomes especially important when front-line health workers (such as physicians, nurses, or allied health providers) face difficulties in diagnosing cases in PHC settings where consultations are of short duration [2], they are confronted with a wide range of medical problems [3], and their information needs are motivated by the specific needs of patient care [3,4]. Davies [5] describes multiple sources of information that are available to physicians for assisting clinical decision making in difficult to diagnose cases, including clinical guidelines and research papers, as well as advice provided by other professionals [5] such as peers, fellow physicians, consultants, and teachers [6,7].

Huth et al. [8] note that physicians often seek advice from human sources when they are looking for readily available and convenient sources of information [8], mostly related to diagnostics, management, and referral strategies [7]. Text books, research papers, and other sources of information may not be adequate to answer their questions as many times physicians are also searching for support, guidance, affirmation, and feedback [9], which requires a synthesis of medical knowledge, patient information, and an understanding of the context of care [4], especially in complex cases [10].

The available studies provide some insights into how physicians seek information while working in PHC settings [2,5,11]. However, as this literature is largely confined to high-income countries, there is relatively little known about how physicians in low- and middle-income countries access or use information from human sources when faced with difficult to diagnose conditions. In these settings, where access to electronic information sources is often scarce, an understanding about advice-seeking behavior from human sources becomes particularly important.

Applying a systems thinking lens to understanding advice-seeking behavior in Pakistan's PHC system is a key component of the healthcare delivery system [12], with PHC physicians being main actors within a complex health system [13]. Their behavior, linkages, relationships, and interactions influence, and are influenced by, the system and its components [14]. Understanding and informing policy processes that are also influenced by human behaviors requires evidence that reflects the behavior of key actors, such as PHC physicians, and how these behaviors interact over time within social networks. Despite efforts to maintain consistency and uniformity in policy implementation through hierarchical control and command systems, there remain variations in how health professionals at the 'street-level' implement such guidance [15].

Systems thinking encourages a dynamic and inter-related perspective of system structure and function, emphasizing the importance of relationships between parts and whole, and the unpredictability of system behaviors [16,17]. Sterman [18] describes systems thinking as an *"an iterative learning process in which we replace a reductionist, narrow, short-run, static view of the world with a holistic, broad, long-term, dynamic view, reinventing our policies and institutions accordingly"*. A systems thinking lens allows us to recognize the importance of long-term change, the power of context, the role of guiding principles (rather than prescriptive control), the centrality of knowledge, and the enabling contributions made by interpersonal and inter-organizational relationships as vehicles for knowledge translation and exchange [19]. It is therefore a powerful lens through which advice-seeking behavior may be understood.

Using methods grounded in systems science, this paper examines the human advice-seeking behavior of PHC physicians in a rural district of Pakistan in the public health sector, analyzing the degree to which the existing PHC system supports their access to human advice and exploring in what ways this system might be strengthened to better meet provider needs. It goes beyond an analysis of what information is sought by physicians – the common objective of needs-based studies – to understand how and from whom that information is sought. Using a systems lens, operationalized in part through social network analysis, explores the richness of interaction through both formal and non-formal relationships in the context of the PHC system and their implications for clinical decision making.

Research questions

The specific research questions of this study are:

- To what degree does the existing structure of the PHC system in Pakistan support physicians in accessing advice from human sources on difficult to diagnose cases?
- To what degree are physicians satisfied with their current access to advice from human sources on difficult to diagnose cases?
- What changes, if any, do physicians recommend to improve their access to advice from human sources on difficult to diagnose cases?

Methods

This study was conducted at the district level in Pakistan from January 2013 to August 2013. District Attock, predominantly a rural district with a population of 1.6 million, was conveniently selected as a case illustration because of its proximity to the principal investigator [20].

In order to align the study questions with the health problems that the district health department considered a priority, targeted key informant interviews were conducted with five district health administrators^a and line-managers^b of vertical health programs who were purposively selected on the basis of their extensive knowledge of the information systems and their experience of working in district health systems. Key informants were specifically asked to nominate two priority health problems for use as case studies in order to map information flow mechanisms and analyze the advice-seeking behavior of physicians working in Basic Health Units (BHU). Tuberculosis (TB) and measles were identified as key priority health problems to be used as case studies in this research. Despite nation-wide coverage of the National TB Control Program, TB remains a long standing problem across Pakistan, with key informants suggesting limited interest and action from BHU physicians related to TB program activities, especially the identification of new TB cases. Similarly, from January to April 2013, 192 measles cases were reported in the Attock district, largely at secondary health care facilities [21], with just three cases identified by the BHU physicians despite the fact that most of these cases were from geographical areas where they should have been reported by their respective BHU. Based on recommendations from the key informants, the study aims were developed:

- To document the flow of information^c on diagnosis and management of TB and measles cases in the PHC system of Pakistan;
- To describe the advice seeking behavior of physicians in situations with difficult to diagnose cases of TB and measles;
- To explore physicians' satisfaction with their access to advice in difficult to diagnose cases of TB and measles;
- To identify and describe possible changes, if any, that physicians recommend to improve their access to advice in difficult to diagnose cases of TB and measles.

In order to address these aims, with a cross-sectional study design and mixed-method approach, we employed three research methods comprising: i) mapping of existing information systems; ii) social network analysis of physician advice seeking behavior; and iii) key stakeholder interviews for in-depth understanding of physician experiences.

Firstly, through documentary review (official memos for policy statements, job descriptions of doctors for roles and responsibilities, and training modules and guidelines for recordkeeping and reporting of suspected cases of TB and measles) and additional information obtained from five

key informants, we mapped the existing flow of information system for assisting physicians in diagnosing TB and measles cases. Illustrations of formal information dissemination systems (Figures 1 and 2) were developed in the form of information flow charts showing the direction of flow of information and roles and responsibilities for providing information/feedback at various hierarchical levels. These illustrations were validated with the respective district health managers and BHU physicians for accuracy.

Secondly, a semi-structured questionnaire was used to conduct a survey for mapping social and professional networks among BHU physicians. We adapted Blanchet and James methodological approach for mapping and analysis of social networks [22,23]. This approach comprises three stages: i) defining the list of actors and members of the network; ii) analyzing the relationships between actors; and iii) analyzing the structure and dynamics of social networks.

The survey questions were structured to identify whom each BHU physician had contacted for advice whenever faced with difficult to diagnose cases of TB and/or measles. All 49 physicians^d were invited to participate through an official intimation from the Executive District Officer for Health. With one exception, all physicians participated in the survey. Participation was voluntary and each physician completed his/her questionnaire in the presence of the principal investigator. In order to develop an egocentric network for analysis, each physician (ego) was asked to identify and name a person (alter) whom he/she had contacted to seek advice when faced with difficult to diagnose cases of TB and/or measles [24,25]. As the scope of this research was limited to map the social networks from a BHU physician's view only, alters were not contacted for confirmation. However, 'name interpreter' questions were asked of the physicians, designed to elicit further information about their respective alters, primarily covering their characteristics and relationship to the focal ego [25]. All different individual actors (egos and alters) were grouped based on their positioning (institutions/job titles) in the healthcare delivery system and placed under seven specific categories (Table 1).

CINET software was used for generating directed-sociographs separately for TB and measles (Figures 3 and 4). A single-headed arrow indicates a directed-tie, from an ego at the tail and respective alter at the arrow-head, indicating the direction of advice seeking [25]. The different shapes represent various categories of actors (node) whereas the line (tie) connecting between two nodes indicates the presence of a relationship for advice seeking.

The analysis of sociographs indicated that a small number of physicians had sought advice when faced with a difficult to diagnose case of TB and measles (13 and

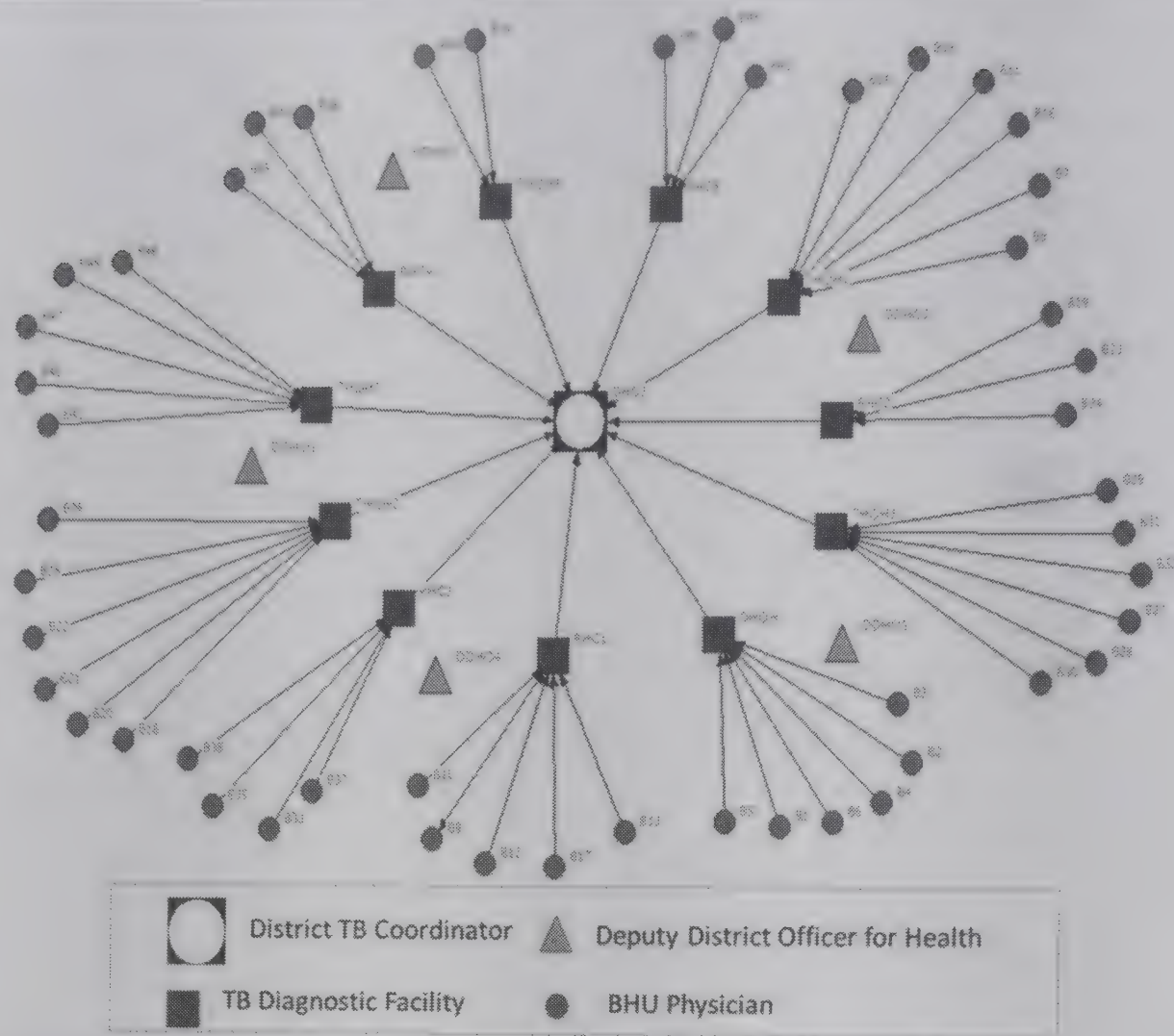


Figure 1 Illustration of flow of information (advice on TB diagnosis) from district to BHU level under National TB Control Program.

12 physicians, respectively). Given these findings, analyses of network properties such as betweenness, centrality, distance, and reachability were not performed. The sociographs provided visual illustrations of the existing network for advice seeking.

Thirdly, we conducted key stakeholder interviews in order to seek clarification and insights into the sociographs and to better understand the experiences of BHU physicians when they were faced with a difficult to diagnose case of TB and measles. Based on the analysis of the findings from sociographs, the BHU physicians were divided into three groups:

- Physicians who sought advice from a person designated by the district health department;
- Physicians who sought advice from someone other than a designated person;
- Physicians who did not seek advice from any other person.

This grouping provided the basis for selecting 11 study respondents for in-depth interviews (sampled from each of the above categories). The key domains explored during these interviews were reasons for seeking (or not seeking) advice, level of satisfaction under the present situation, and suggestions for improvement.

Interviews were digitally recorded and the average interview time was 20 minutes. All interviews were transcribed and content analysis was carried out by organizing coded data into categories, subthemes, and themes using an inductive process.

Results

Characteristics of BHU physicians

The study population of 48 BHU physicians comprised 41 males and 7 females. Average duration of government services was 6.7 years, ranging from 1 to 18 years. One-third ($n = 16$) of the study participants completed medical graduation overseas (mostly from Central Asian states). Further details are given in Table 2.

The formal system of information flow for diagnosing TB and measles cases

Under the National Tuberculosis Control Program (NTP), a District TB Coordinator (DTC) is responsible for administrative management of NTP activities at the district level. The DTC is also responsible for conducting trainings on Directly Observed Treatment Short-course (DOTS) strategy.

The District and Tehsil Headquarters Hospitals (DHQH & THQH)^e and Rural Health Centers^f are established as TB diagnostic centers with nomination of a TB

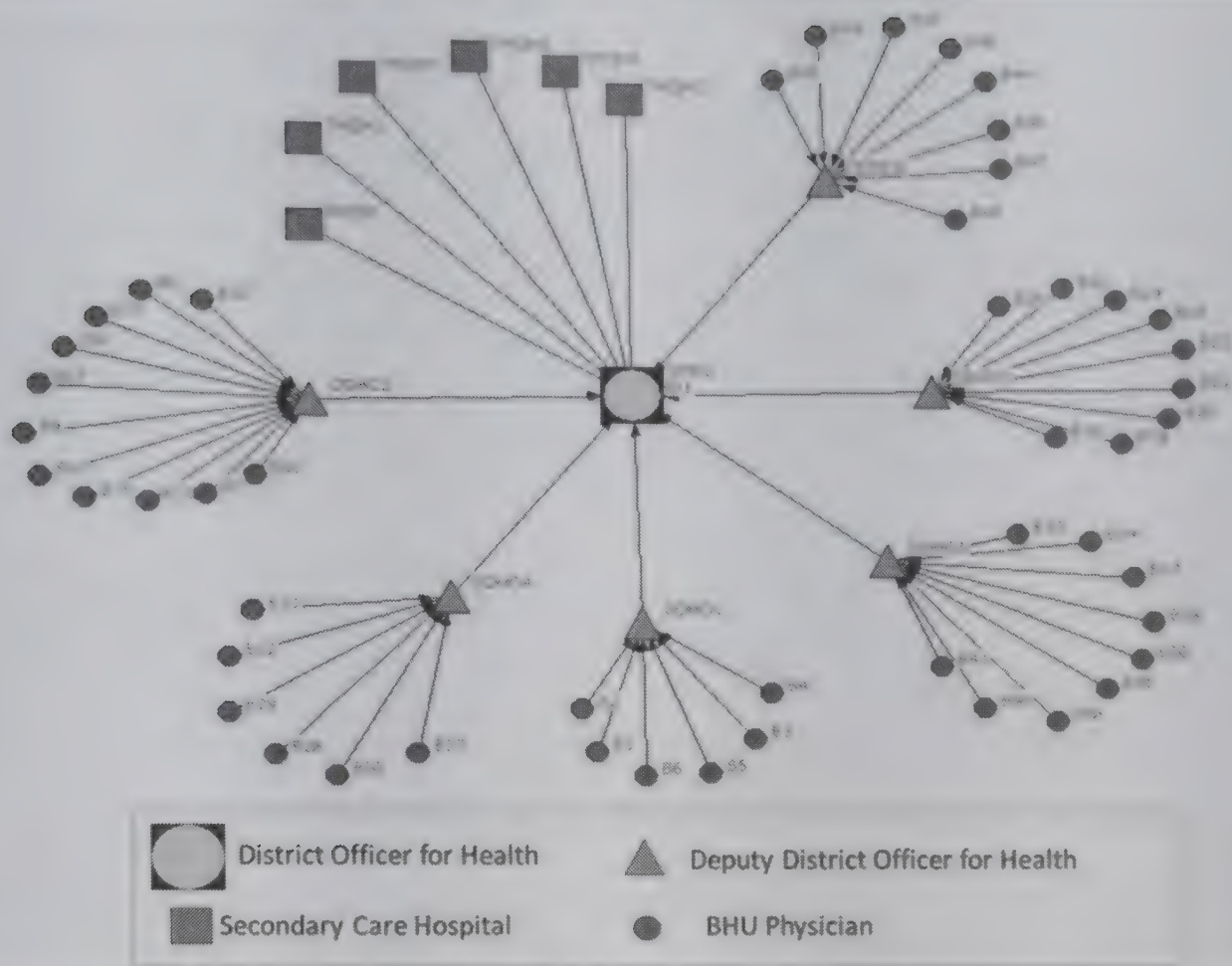


Figure 2 Illustration of flow of information (advice on Measles diagnosis) from district to BHU level under Expanded Program on Immunization.

focal person and upgradation of laboratory services for sputum and radiological examination service.

All 61 BHUs across the district are grouped in 11 clusters and every cluster is attached with a TB diagnostic center on the basis of geographical proximity. This administrative change has provided a formal link between primary and secondary health care facilities but only for matters related to TB. In their monthly meetings, BHU physicians are required to meet with the TB focal person at their respective TB diagnostic facility, who is expected to provide follow-up of patients referred by BHU physicians for confirmation of diagnosis, provide clinical advice and training, and advice on other programmatic issues.

The flow of information under the Expanded Program on Immunization (EPI) follows the organizational hierarchy of the district health care delivery system which is aligned with the geographical boundaries of district and sub-district levels. In comparison to NTP, the BHUs are not clustered around another hospital or higher level health facility, but rather the administrative office of the Deputy District Officer for Health (DDOH). In order to seek advice on issues related to the EPI (including measles), BHU physicians are expected to contact their respective DDOH (their immediate supervisor at Tehsil level). Further, in contrast to NTP, they do not have direct linkage with secondary care hospitals. The DDOH

is also responsible for training on EPI, with facilitation from the District Officer for Health.

Structure of professional and social networks for advice seeking

The structure of the social network for advice seeking reveals that 27% BHU physicians ($n = 13$) contacted a human information source when faced with a difficult to diagnose case of TB (Figure 3).

Ideally, as per the specified criteria established by the NTP [26], all were expected to contact the TB Focal Persons at their respective TB diagnostic centers (Figure 1); however, only two physicians contacted their designated source for advice. Among those that sought advice from an alternative source, four directly approached the DTC for an expert opinion, two consulted each other, whereas one sought advice from the respective DDOH. All contacted someone within the district except three who preferred to seek advice from a tertiary care hospital located externally to the district (Figure 3). The sociogram demonstrates a mixed pattern of advice seeking which is not consistent with expectations under the NTP.

The structure of the social network for advice seeking for measles demonstrates that 25% of BHU physicians ($n = 12$) contacted a human information source when faced with a difficult to diagnose case of measles (Figure 4).

Table 1 Grouping of actors and institutions in seven categories

No	Category	Number
1	District Coordinator for National TB Control Program	1
2	Deputy District Health Officers	5
3	TB Diagnostic Health Facilities	11
4	BHU Physicians	49
5	Consultants in Secondary Care Hospitals	1
6	Consultants in Tertiary Care Hospitals	3
7	Private Practitioners	1

As per the departmental directions, all of the BHU physicians were expected to contact their respective DDHOs; however, only three physicians contacted their immediate supervisor. This finding was observed in one Tehsil only, with no physicians in the remaining five Tehsils seeking advice from their respective DDHOs. Four physicians preferred to contact a pediatrician in a single THQH. A similar number of physicians sought advice from another BHU physician. Only one physician contacted a private practitioner for advice. This pattern shows some differences from the advice-seeking network for TB because none of the physicians sought advice from outside the district.

The next section presents thematic analysis of the qualitative research findings from in-depth interviews.

Qualitative findings from the in-depth interviews

The transcripts were coded and then organized into categories from which three subthemes and one main theme were identified. The analysis process is given in Table 3. The data from qualitative research findings are presented starting with the subthemes and their relation to the categories and concludes with how they contribute to the main theme.

Subtheme 1: lack of confidence in available resources

All physicians had been working in BHUs for at least a year and were aware of the constraints and challenges associated with the BHU environment. They lacked confidence in the available resources for clinical guidance within the system.

Physician considers first line officer incompetent

Among those physicians who did not seek advice in relation to a complicated case of measles or TB, some suggested that the available experts within the district health care delivery system were not of the relevant field or lacked competence.

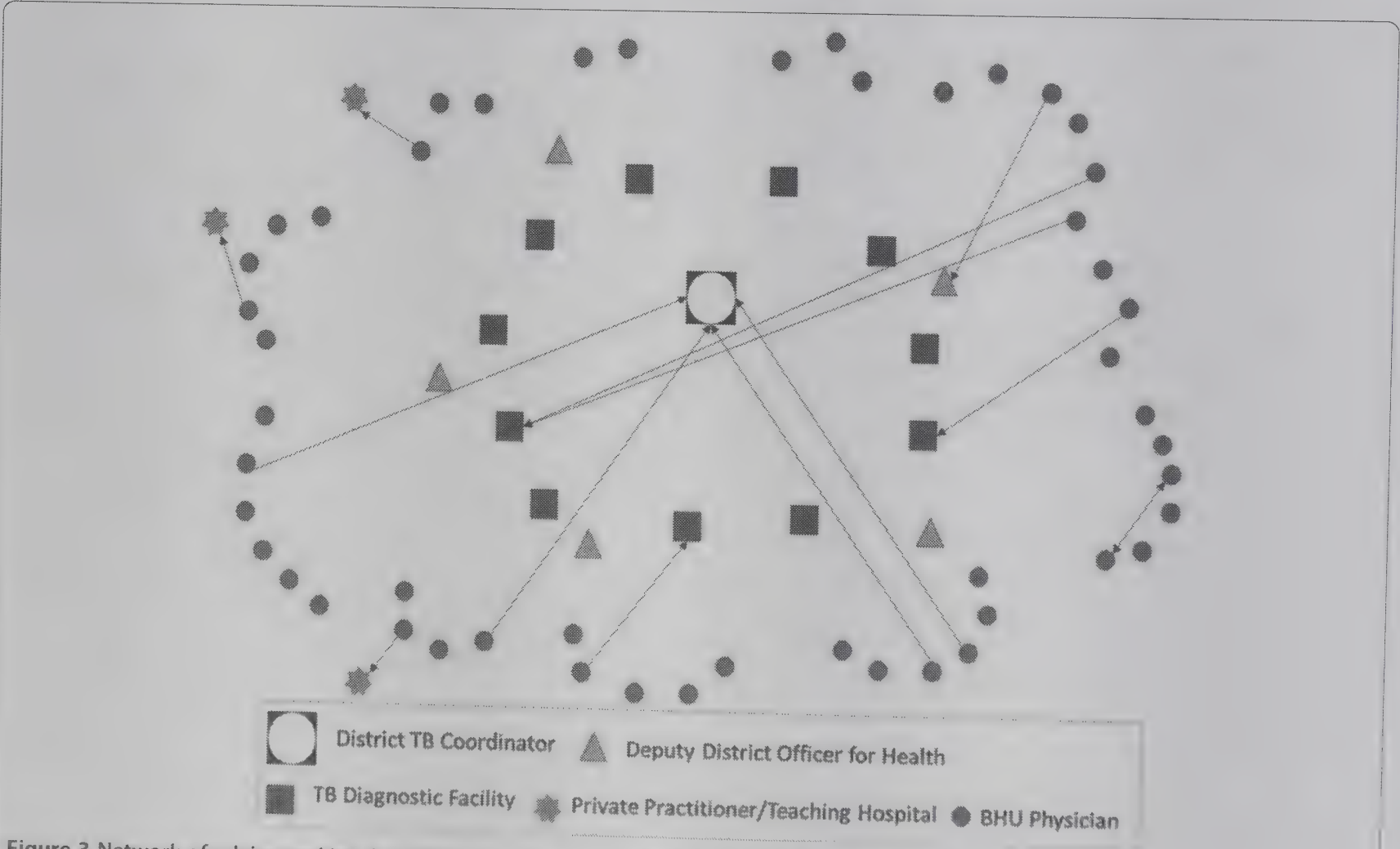


Figure 3 Network of advice-seeking for difficult to diagnose cases of TB among BHU physicians.

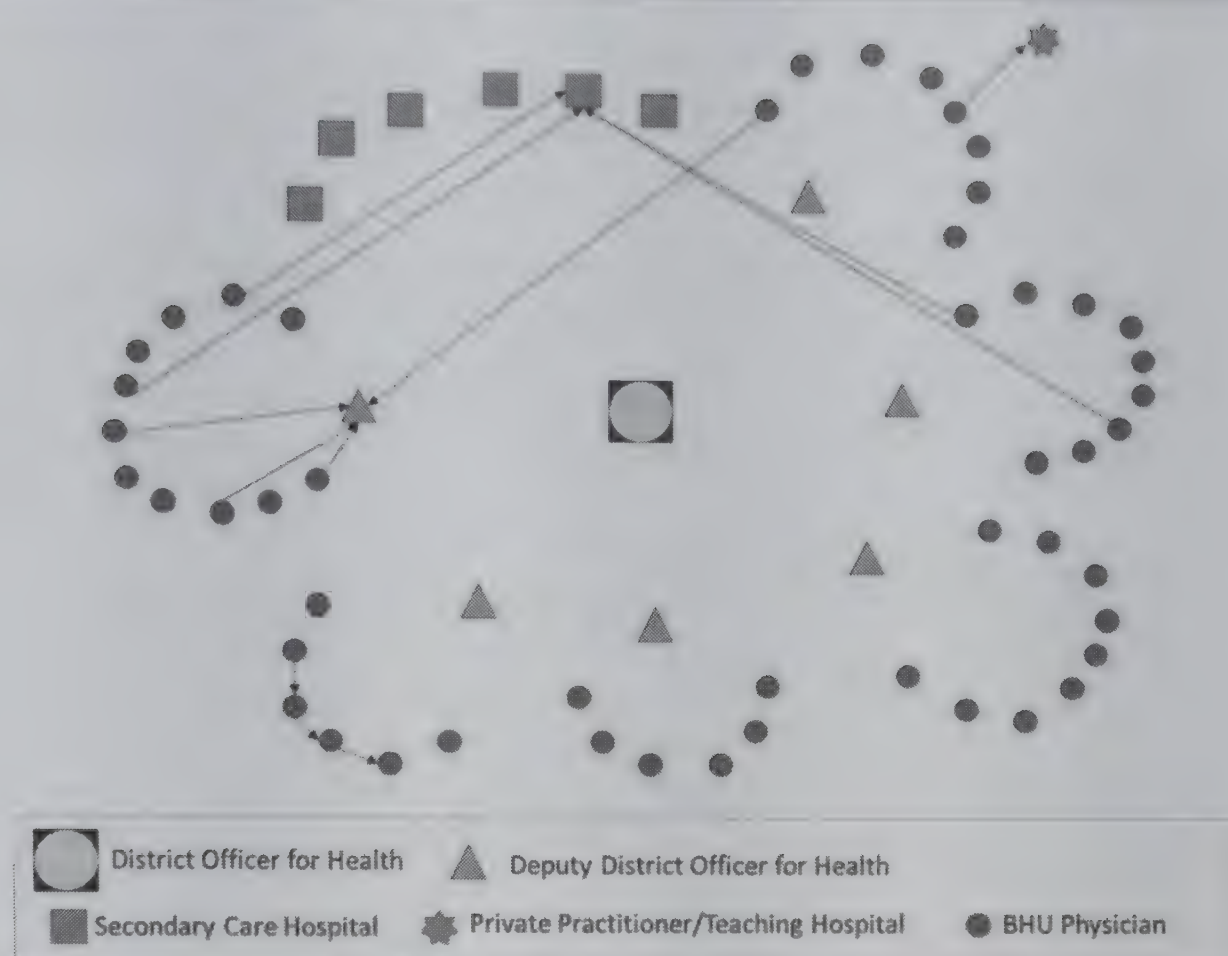


Figure 4 Network of advice-seeking for difficult to diagnose cases of measles among BHU physicians.

"First of all, the doctors posted at TB diagnostic center should be competent enough. The doctor posted presently over there is not competent; I have no faith in him. Moreover, the position of medical specialist at THQH should be filled. Presently, a doctor is available at this hospital who has done his diploma in cardiology. Personally speaking, I don't think he is competent enough to deal with TB patients."

Another physician reflected:

"He is not an experienced person. Sometimes, he shows an X-ray to me to seek guidance on what to do further. For example, recently, he showed me an X-ray for advice whether that patient should be put on

Streptomycin. I don't consult him for advice because he is not that competent."

Physicians were aware of the limitations of their reporting officers or immediate supervisors and reported seeking advice from them in administrative issues only. Four physicians felt that they had not encountered any difficulty in diagnosing any difficulty and hence, did not seek advice from anyone.

Lack of support system for clinical guidance

For clinical advice related to measles, physicians reported trust in the opinion of pediatricians, while for TB, physicians reported willingness to contact the district TB coordinator. The need to improve access to those with relevant expertise was expressed, as was a formal mechanism within the PHC system for facilitating access to clinical guidance in a timely fashion. In addition, BHU physicians also reported being overworked with organizing different campaigns and activities and were left with little time for patient care:

"There should be a mechanism through which we can meet the specialists or have training session with them at least after every 2 to 3 months so that they know the BHU doctors and understand their problems. Although BHU doctors are performing their duties, it is a general perception that nothing is done at the

Table 2 Characteristics of BHU physicians in Attock district

Characteristics	Proportion (Number)
Attained medical education within Pakistan	66% (n = 32)
Employed as regular government employees	50% (n = 24)
Established private clinic besides government job	54% (n = 26)
Attended formal training on EPI* before joining service	66% (n = 32)
Attended formal training on TB DOTS** before joining service	85% (n = 41)

*EPI, Expanded Program on Immunization; **TB DOTS, TB Directly Observed Treatment Short-course.

Table 3 Analysis process moving from categories to themes

CATEGORIES	CATEGORIES	CATEGORIES
1. Physician considers first line officer incompetent	1. Specialist reachable over phone for advice if personally known	1. Lack of trust in organizational pathways for seeking information for patient care
2. Lack of support system for clinical guidance		
3. Lack of access to latest literature/research from the Health Department	2. Focus of departmental meetings on targets and not clinical guidance	2. Personal professional/social network (locally and distant) for patient care
4. Lack of functional referral system		
SUBTHEME 1	SUBTHEME 2	SUBTHEME 3
Lack of confidence in available resources	Unpredictable support	Reliance on personal (rather than organizational) resources to safeguard patients' interests
MAIN THEME		
Formal organizational structures, including supervisory support and technical guidelines, not adequate		

level of BHUs. There is no one in a BHU after 11 am. These days, BHU doctors are heavily engaged in activities like Dengue control, measles vaccination campaign, and other official meetings. There is a single doctor posted at BHU level and when he is to remain away on account of all these official engagements, who will take care of the patients?"

Lack of access to latest literature/research from health department

The main reliance of physicians for information was through other doctors and text-books:

"If I require advice then I would prefer to reach out to my seniors because they have practical experience. I have never read research papers."

The internet was used to access information on complicated cases by some physicians; however, access to the internet was not available at every BHU. Other resource materials identified were pamphlets and brochures from representatives of pharmaceutical companies and hand-books on clinical guidelines. The health department did not provide such information:

"There should be some system that BHU doctors remain updated with new developments. We will keep on making our personal efforts but there should be an official system, which should facilitate our access to updated information and research."

Lack of a functional referral system

There was also a lack of a functional referral system. As such, even when physicians consulted someone or referred them to another provider within the system, there

was no mechanism in place to ensure feedback to the referring physician:

"In case of diagnosis, I make a provisional diagnosis based on my clinical knowledge and books and then refer the patient accordingly. If the patients come back to my center afterwards, I get feedback from them."

Reiterating the non-functional feedback system, the physicians considered that it was more convenient to simply refer a suspected case of TB to a TB diagnostic facility without differentiating between a difficult or easy to diagnose case.

Subtheme 2: unpredictable support

Interviewed physicians suggested that the health system worked in 'spurts', with the fluctuating functionality of the system physicians were driven to look for alternate sources when faced with complicated cases requiring advice.

Specialist reachable over phone for advice, if personally known

Specialists at times were available and reachable over the phone for advice on management/complications. This, however, was true in cases only when they personally knew the specialists and were close enough to them to call them.

"I often contact Dr. A when I face problem in managing the treatment of TB patients. As far as history, symptoms and signs of TB are concerned, I think, I don't have any problem with that. Further, 20–30% diagnosis is confirmed by the laboratory tests at the diagnostic center. Dr. A is our master trainer for TB program and I

know him – that is why I often contact him for further advice.”

Moreover, the referral center had the facilities for carrying out further tests.

“The patient presented with enlarged and matted cervical lymph nodes. I talked to Dr. B about her and then she was referred to him because we thought she might require a biopsy. They have more facilities available at the THQH level.”

Focus of departmental meetings on targets and not clinical guidance

Within the health department, most meetings focused on setting targets and achieving them. Clinical management was discussed only when a senior doctor was personally interested in clinical management and also competent to carry out such discussions. The support system to provide clinical guidance was non-existent. Thus, the system fluctuated as different doctors were appointed:

“We participate in so many monthly-meetings because we have to remain in touch with our superiors and seniors. These meetings are not focused on diagnosis and patient management, rather the stress is on achieving our targets irrespective of whether these are achievable or not. Focus is more towards paperwork but not towards practical work.”

Subtheme 3: reliance on personal (rather than organizational) resources to safeguard patients' interests

Physicians were motivated to seek advice and provide care to their patients. They realized the constraints within which they worked and had to provide best care to the patients.

Lack of trust in organizational pathways for seeking information for patient care

The physicians knew that there was no formal mechanism to seek advice within the system and there was a lack of trust in organizational information-seeking pathways as well. This was based on their own experience of not finding competent physicians posted at the higher health care facilities. Through their own professional network they sought advice:

“Dr. C is a friend of mine and I can contact him easily.”

One physician described how a personal experience with illness influenced his advice-seeking behavior and the need to safeguard patient's interest to seek care:

“Because I had suffered from the same situation myself; therefore, I directly contacted Dr. B. I had become so afraid of TB at that time because I was in my final medical year and exams were due in just a few months and my case was so much mismanaged. It is generally said that one becomes more sympathetic to a patient who shares the same experiences of suffering that a health provider has also gone through. That is why I referred this patient to a proper place so that they do not wander from place to place and get a trustworthy opinion.”

The referring physicians indicated that there were internal contradictions in communicable disease reporting mechanisms: the reporting of cases of vaccine-preventable diseases, including measles, was received with some ambivalence by the higher authorities, given that they had been reporting high vaccine coverage for many years. The consequences for communicable disease surveillance were understandable, but undesirable; physicians were inclined not to document and report such cases. In complex cases of measles, it was easier to avoid negative consequences for the referring physician by not using formal reporting channels, but instead referring them directly to a pediatrician, outside the PHC system:

“The more important thing is that every case of measles should be reported so that proper information is available in the health system. However, this is not the case in practice. Once you are discouraged by the high-ups that such cases are not to be reported, the doctor himself avoids reporting cases of measles so that he does not face any consequences. Being positioned at BHU level, we do not like to bear the responsibility. Therefore, if any case of measles turns up with or without complication, we do entertain him and refer him to a higher level of care but without the official reporting that is required in such a case.”

Personal professional/social network (local and distant) for patient care

Many physicians used personal links to seek information for their patients. On encountering a complicated case, physicians reported reliance on other physicians/specialists they knew personally and could call over the phone to consult (even when specialists were present within the district health care system):

“It depends upon the specialty or the type of the cases. For example, for Gynecology and Pediatrics I contact Dr. X (Gynecologist) whereas for pediatrics I contact Dr. Y (Pediatrician). For other cases I contact my colleagues and friends even outside the district because every specialist within the district cannot be contacted

on personal relationship. For example, it is not possible to contact Dr. Z (Medical Specialist at DHQH) because he is not known to me."

Main theme: formal organizational structures, including supervisory support and technical guidelines, not adequate

The main theme identified from the perspectives of interviewees illustrates how their work setting and information/advice-seeking patterns are driven by the constraints in organizational structures. It is difficult for BHU physicians to ensure comprehensive responsibility to their population if their efforts are not supported by specialized services available at secondary and tertiary levels of health-care [1]. Getting their part of the system right does not help if other system components do not provide the required support [27]. Non-availability of competent supervisory staff, a focus on improving performance indicators rather than clinical guidance, and the lack of a functional referral system, collectively create an environment that is non-conducive for improving patient care. In the long term, physicians develop their own strategies to overcome these constraints. Their advice-seeking patterns largely depend on access to information systems and their contacts with colleagues within and outside the primary health care system. Non-responsiveness of the healthcare delivery system creates an environment where they work in isolation. Ultimately, it has negative consequences both for shouldering responsibilities and improving quality of care.

Discussion

As noted by the WHO, the building blocks of health systems (service delivery; health workforce; information; medical products, vaccines and technologies; financing; and leadership and governance (stewardship)) while independently critical for system effectiveness, do not operate in isolation: complex relationships between the building blocks may help (or hinder) the overall ability of a system to use resources for improving health [12]. Human resources and information flow (two of the six building blocks), therefore, play critical roles in connecting sub-systems, promoting ongoing learning, and driving performance improvement. Examining how those within health systems share, access, and apply information is therefore important for better understanding how existing system structures and functions support or hinder learning and improvement.

Here, we discuss the implications of this study's findings across four domains: system organizing, system networks, system dynamics, and system knowledge [13].

System organizing

The designers of the NTP and EPI have achieved the program-specific institutional arrangements that they

require at the sub-district level by clustering BHUs around TB diagnostic facilities and offices of the DDHOs, respectively, with additional administrative and managerial support provided from the district level. These institutional arrangements have provided an organizational skeleton for administration, training, and reporting through setting rules and regulations and assigning roles and responsibilities. However, these efforts have focused on establishing managerial control over program activities rather than nurturing a learning oriented environment that BHU physicians could rely on for advice, particularly when confronted by difficult to diagnose patient presentations. Consistent with previous reports from other jurisdictions [2,20,28], this study has identified non-availability of expertise and lack of a functional referral system as key deficiencies within the existing PHC system, exacerbated by limited interconnections between BHU physicians and those providing higher, specialist levels of care. Moreover, even where designated centers do exist (such as in TB diagnostic facilities), BHU physicians rarely perceive these as authoritative or expert learning resources. Similarly, EPI line-managers (DDHOs) were infrequently contacted for advice, primarily due to a perceived lack of clinical knowledge related to the management of measles. The absence of a functional and reliable referral system further compounded this situation. Consequently, BHU physicians were more reliant upon their own knowledge and relationship to identify appropriate sources for advice.

Systems networks

As noted, the findings from this study demonstrate that the information-seeking behavior of BHU physicians are diverse, driven by both the context and their network of available relationships, and do not follow formal organizational structures. The boundaries of information-seeking behavior do not appear to be limited by geography (district/province), type of health sector (public/private), or levels of healthcare (primary, secondary, and tertiary). Results from the qualitative investigation suggest that the presence of appropriate social ties (relationships) largely determine how physicians in this setting seek information from other human sources. In the Pakistani health system (as in other systems), specialist doctors are posted and available in the secondary and tertiary care hospitals with few formal linkages to the PHC infrastructure. Our study findings show that, while BHU physicians were aware of the human expertise available within and outside the district, their information-seeking behavior was largely influenced by their informal interactions and relationships with senior specialists.

Health systems are driven by humans and their interactions [29]. However, the existing PHC system in Pakistan does not appear to support or nurture relationships between junior and senior physicians. Participants in this

study suggested a number of ways in which such connections may be fostered, such as greater in-service training events, more regular opportunities to work beside senior doctors, or even activities that build stronger connections between public and private sectors.

System dynamics

Health systems are not static and adjust and readjust over time as contexts change, feedback is provided, and histories develop. The human instrument, unlike other resources, has the ability to cope and adjust to its environmental needs. Lack of response from higher authorities, discouraging attitudes, especially in the case of reporting vaccine preventable diseases (e.g., measles), and absence of feedback mechanisms, may demoralize frontline health-care providers leading them to develop their own strategies outside formal accountability systems. Despite the limitations of the existing PHC system, a number of physicians in this study reported proactively using their professional linkages, experiences, and relationships to seek information and refer patients. However, there currently exists no process whereby referred patients may be followed-up in PHC centers. As a result, many physicians were not confident of the outcomes of referral under these circumstances, with patients often 'lost in the system'. Although patient referral was occurring, long-serving public sector physicians were skeptical that a functional referral system could or would be created.

Systems knowledge

While authority lies in knowledge [30], health system managers in this study were largely viewed as administrators lacking in clinical expertise. As a result, BHU physicians' information-seeking behavior tended to be driven by perceptions of clinical expertise rather than hierarchical positioning or seniority. With inadequate use of resources to support physician training in TB DOTS and EPI prior to joining services, and a focus on management targets rather than clinical outcomes, BHU physicians developed their own learning and improvement strategies. Yet, without a supportive learning culture, many opportunities for better managing, sharing, and improving knowledge were missed, leading to isolation for many BHU physicians. In the absence of formal systems that meet their needs for clinical advice, individual physicians draw on their own networks of resources, and this in turn creates emergent organization that partly compensates for the gaps, but without addressing their causes.

Limitations of the study

This study has a number of limitations. Firstly, the scope of the investigation was restricted to two specific diseases, TB and measles, in the context of a single district.

Therefore, while the results are informative, they cannot be generalized to other diseases and geographical areas. Secondly, the network data were based upon the information provided by the PHC physicians. We did not contact the respective senior doctors for confirmation of the reported ties because it was beyond the scope of this research. Thirdly, this study has been conducted in public sector PHC facilities only and does not cover private sector PHC general practitioners who are a major source of service provision in Pakistan. However, as more than half of BHU physicians also work in the private sector, it is possible that findings may be similar across practice settings. Despite these limitations, the lessons learned could potentially be used in designing studies for providing comparative analyses in different contexts.

Conclusions

Through the examples of TB and measles, this study has demonstrated how and why PHC physicians seek information when confronted with difficult to diagnose cases, and the challenges of creating learning systems that support continuous improvement. Given the number and diversity of patient presentations seen each day by PHC physicians, it is possible that there exists a more generalized need for high quality, reliable, and accessible information. Yet the absence of functional referral systems, limited effective linkages between PHC and higher levels of care, and a focus on programmatic targets rather than clinical care, have each contributed to the isolation of physicians and reactive information-seeking behavior. The advice-seeking behavior observed in this study may be explained by physician's lack of confidence in available information resources, an unpredictable patient referral system, and a greater belief in personal rather than organizational resources for ensuring high quality patient care. Through interpreting these findings in partnership with those responsible for system design, it may be possible to assist provincial health departments in Pakistan to review the modalities of providing support to PHC physicians, especially in the country's post-devolution phase. At this time, organizational and structural changes have a high potential of being entertained and implemented. The study findings underscore the need for a functional information system comprising context-sensitive knowledge management and translation opportunities for physicians working in PHC centers. Such an information system needs to link people and resources in ways that transcend geography and discipline, and that builds on existing expertise, interpersonal relationships, and trust.

Endnotes

^aExecutive District Officer for Health, District Officer for Health and Deputy District Officer for Health.

^bDistrict Coordinator for National Tuberculosis Control Program, District Superintendent for Vaccination, Program Director for District Health Development Center, Coordinator for District Health Information System.

^cFor this paper, the flow of information is defined as formal mechanism of information exchange (reporting on case detection of TB and measles, through trainings, and advice seeking) in public sector health care delivery system at district level.

^dOut of 61 BHUs in district Attock, physicians were appointed in 49 BHUs and the remaining positions were vacant at the time of survey.

^eSecondary Care Health Facilities.

^fA higher level PHC facility at a level between BHUs and secondary care health facilities.

Abbreviations

BHU: Basic Health Unit; DDOH: Deputy District Health Officer; DHQH: District Head Quarter Hospital; DTC: District TB Coordinator; DOTS: Directly Observed Treatment short-course; EPI: Expanded Program on Immunization; NTP: National Tuberculosis Control Program; PHC: Primary Health Care; TB: Tuberculosis; THQH: Tehsil Headquarters Hospital.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

AUM led the research design and implementation as a principal investigator. AUM and SH conducted document review and developed illustrations of information flow mechanisms. AUM and AU conducted social network analysis whereas SH analyzed qualitative research findings. PSH contributed to thematic analysis. AUM drafted the manuscript. CDW, SH, and PSH contributed to and reviewed the manuscript. All authors have read and approved the final manuscript.

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RESEARCH

Open Access

Advancing the application of systems thinking in health: exploring dual practice and its management in Kampala, Uganda

Ligia Paina^{1*}, Sara Bennett¹, Freddie Ssengooba² and David H Peters¹

Abstract

Background: Many full-time Ugandan government health providers take on additional jobs – a phenomenon called dual practice. We describe the complex patterns that characterize the evolution of dual practice in Uganda, and the local management practices that emerged in response, in five government facilities. An in-depth understanding of dual practice can contribute to policy discussions on improving public sector performance.

Methods: A multiple case study design with embedded units of analysis was supplemented by interviews with policy stakeholders and a review of historical and policy documents. Five facility case studies captured the perspective of doctors, nurses, and health managers through semi-structured in-depth interviews. A causal loop diagram illustrated interactions and feedback between old and new actors, as well as emerging roles and relationships.

Results: The causal loop diagram illustrated how feedback related to dual practice policy developed in Uganda. As opportunities for dual practice grew and the public health system declined over time, government providers increasingly coped through dual practice. Over time, government restrictions to dual practice triggered policy resistance and protest from government providers. Resulting feedback contributed to compromising the supply of government providers and, potentially, of service delivery outcomes. Informal government policies and restrictions replaced the formal restrictions identified in the early phases. In some instances, government health managers, particularly those in hospitals, developed their own practices to cope with dual practice and to maintain public sector performance. Management practices varied according to the health manager's attitude towards dual practice and personal experience with dual practice. These practices were distinct in hospitals. Hospitals faced challenges managing internal dual practice opportunities, such as those created by externally-funded research projects based within the hospital. Private wings' inefficiencies and strict fee schedule made them undesirable work locations for providers.

Conclusions: Dual practice prevails because public and private sector incentives, non-financial and financial, are complementary. Local management practices for dual practice have not been previously documented and provide learning opportunities to inform policy discussions. Understanding how dual practice evolves and how it is managed locally is essential for health workforce policy, planning, and performance discussions in Uganda and similar settings.

Introduction

Dual practice, when health workers employed full time by the government take on additional jobs, is widespread in developing countries, particularly those with growing private sectors. Recent studies found that 29% of physicians in Cote d'Ivoire, 35% of physicians in Vietnam, 42% in Sri Lanka and 41% in Zimbabwe, and as high as 80% in

Indonesia and Bangladesh, held second jobs [1-5]. In some contexts, dual practice can be broader than private for-profit sector service delivery – including both research and NGO work. Researchers and policy-makers in developing countries display increasing interest in how dual practice affects the health system [6,7].

Uganda is one of these countries. The country has a vibrant private health sector. Within this, the private not-for-profit health sector has, for decades, been acting as an extension of the public one, especially after the public health sector was mostly destroyed during the

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period of civil war and remains underfunded to date. Uganda's private for-profit sector is large, fragmented, and disorganized, yet very little is known about it. Although there are growing discussions about public-private partnerships in health [8], dual practice seldom features on these agendas and data on this topic is scarce. In Uganda, in 2005, a nationally representative survey of private health facilities found that more than half (54%) of private sector doctors also declared being formally employed in the public sector [9]. While estimates from public facilities do not exist, in general, health providers and policy-makers perceive that almost all government-employed health workers have dual practice. In addition, dual practice has been rising in importance on the policy agenda due to media reports of adverse health service delivery outcomes [10,11], as well as suspected linkages to absenteeism and the wastage linked to it [12,13]. A recent study aiming to establish policy-makers' research priorities revealed that a principal concern was dual practice that was *"reported to greatly affect the performance of the public sector. The dual [practice] of public health workers has implications on quality and management of health care delivery such as indiscipline, time loss and poor work ethics"* [7].

Despite these concerns, data on dual practice in Uganda and elsewhere is scarce. Although many types of health providers are believed to engage in dual practice, the available literature examines dual practice rather narrowly, generally only from the perspective of physicians. Furthermore, existing studies provide few answers to questions related to the policy and management of dual practice, beyond agreement that the effects of dual practice on the organization of the health system and service delivery can be either positive or negative, and that these effects, and related policy responses, are highly dependent on the local context [14-16]. For example, if well managed, dual practice may help prevent doctors from leaving the country by enabling them to supplement salaries without adversely affecting stock of doctors in the country. Conversely, if poorly managed, absenteeism and pilfering may negatively affect public sector standards of care and contribute to inefficiencies. The factors and interactions that drive these effects have not been explored extensively. Presumably, these factors depend on how dual practice has evolved and how it is managed in a particular health system.

Studying the dynamic aspects of dual practice and related interactions both within and outside the boundaries of a health system requires a departure from the linear, theoretical models found in the literature [2,17-20]. A more appropriate model acknowledges the holistic, complex, and adaptive nature of health systems and their broader environment. Complex systems are composed of many interacting components that organize themselves in

dynamic ways, are unpredictable in the long-term, and are able to learn from past experiences [21-23]. A research design acknowledging complex systems' features, as well as potential interactions due to contextual factors, is ideal to guide the exploration of phenomena, such as dual practice, from multiple perspectives. It facilitates the exploration of complex system characteristics, such as feedback, emergence, and self-organization. In this paper, we explore how dual practice evolved in the Ugandan health system and how it is currently managed, in an urban environment – the city of Kampala, with an active private sector. Additionally, using systems approaches, we attempt to reflect on why dual practice persists and the factors underlying its current management. Understanding dual practice holistically in the Ugandan context provides a basis for exploring potential policy options. Gaining an in-depth understanding of the role of dual practice at various levels of the system can help policy-makers and health managers to strengthen management of dual practice and its consequences.

Methods

Research design

We use case studies of urban public health facilities to investigate the role of dual practice and the key patterns and interactions that it motivated in the health system. Review of policy documents, as well as qualitative interviews of policy stakeholders were used to supplement a qualitative survey of workers and their managers in the study facilities. In addition, during the data analysis phase, we developed a causal loop diagram to illustrate key factors and related feedback influencing dual practice in the current context. This paper presents only a sub-set of data that were collected as part of a sequential, exploratory mixed methods study.

We purposefully selected five public sector health facilities in Kampala, Uganda, to represent the various levels in the Ugandan government health system: two Health Center III facilities, one Health Center IV facility, and two urban hospitals (see Table 1 for case characteristics). Health Center III facilities have a general outpatient clinic and a maternity ward. Health Center IV is a larger facility than the Health Center III facilities, with the capacity for inpatient services and some emergency operations. Regional referral hospitals have specialized clinics, and are staffed by a variety of cadres, including medical specialists. The national referral hospital also has research and teaching components, in addition to medical service provision. Within these case studies, individual respondents were purposefully selected to ensure that, at each facility, the perspectives of providers (doctors and nurses) and the facility manager, were captured [24]. At each facility, the sample included the health facility manager (in-charge in health centers, directors or department heads at hospitals),

Table 1 Summary of selected cases

Facility type	Case A	Case B	Case C	Case D	Case E
Health Center III*	X	X			
Health Center IV			X		
Hospital				X	X
Location					
Central		X		X	X
Periphery	X		X		
Staff composition					
General practitioners			X	X	X
Specialists				X	X
Nurses	X	X	X	X	X
Filled positions	121%	74%	90%	144%	90%

Source: Ministry of Health – Human resources for health audit [25].
*Note: Health Center III units are supposed to be staffed by Clinical Officers and Nurses – although sometimes units do have a Medical officer as well.

as well as a doctor and nurse recommended by the health facility manager. Within the larger hospital, the sampling occurred at the level of the clinical specialty [1], and therefore included multiple manager-level respondents, as well as a nurse and a doctor recommended by each of them. Within the smaller hospital, the sample included the director and two providers recommended by them.

Policy stakeholders included purposefully selected individuals from professional councils, relevant government ministries, private not-for-profit medical bureaus, private sector hospital administration, and the local district health office. The main criteria guiding the sampling was the extent to which a stakeholder would know policies on dual practice either at the national level or within their organization, would have a stake in the development of a policy on dual practice, and present a unique perspective on dual practice in the Ugandan context.

Data collection instruments and field work

A review of policy documents was undertaken before the data collection, and as these documents became available. The main areas of interest were the existence and content of policies, actors, and events that played a role in the evolution of dual practice in Uganda, as far back in time as possible.

The interview guides contained questions about the evolution of dual practice in Uganda, providers’ motivation to engage in dual practice, advantages and disadvantages or challenges linked to dual practice, facility-level policies and management approaches, and potential policy recommendations. Interviews with policy stakeholders focused on policy-related questions, as well as on the evolution of dual practice in the health system. Data collection took place during July–August 2012. The interviews were conducted in English. Interviews were recorded, unless respondents preferred otherwise.

Data analysis

All of the recordings were transcribed and stored in Atlas.ti v. 7. A preliminary, exploratory coding structure was constructed based on initial readings of the transcripts and on the conceptual framework derived from a systems approach to health markets and theories related to systems thinking and health worker motivation [21-23,26,27]. Multiple rounds of coding focused on refining the scheme [28]. During coding and analysis, memos were developed to capture changes in the coding structure, as well as emerging reflections.

Text query results from Atlas.ti were arranged in matrices for within and cross-case analyses, according to the methods suggested by Miles and Huberman [24]. For each case, matrices were developed by theme (e.g., informal organizational policies), with focus on the embedded units of analysis (e.g., summarizing and contrasting the perspectives of health facility managers, doctors, and nurses). Cross-case theme analyses focused on exploring the differences and similarities between the five cases, specifically by health facility type. The policy stakeholder interviews were analyzed for emerging themes, along the same lines as the case studies. References to the analysis and any quotes are labeled according to respondent type, to maintain anonymity.

Causal loop diagram development

Although it was not an explicit goal of this study, interviews with policy-makers revealed that the role of dual practice and the government policy on dual practice changed over time, and that examining this progression might be useful for understanding the current policy situation. Based on discussions with policy-makers and case study respondents, as well as available historical accounts, we developed a causal loop diagram (CLD). The CLD illustrates the events, actors, and interactions – or the underlying mental model and system behavior – that fostered the emergence of dual practice policy responses over time in the Ugandan health system, facilitating the visualization of complex system patterns and characteristics, such as policy resistance, feedback, and adaptation [29,30].

The CLD was developed using Vensim PLE Plus [31]. It was challenging to recreate the history of dual practice, particularly in the distant past. An account of the medical profession in East Africa, which included details about the emergence and development of dual practice and the private sector from the perspective of physicians, helped to identify relevant early events from the 1960s and the 1970s [32]. Recent events have been identified from the in-depth interviews conducted for this study and available documents. The CLD was refined through various iterations, to ensure that the relationships, interactions, and direction of feedback were most plausible.

The CLD uses standard notation: “a positive (+) arrow from variable A to variable B means that A adds to B, or, a change in A causes a change in B in the same direction; a negative (–) arrow from A to B means that A subtracts from B, or, a change in A causes a change in B in the opposite direction” [33]. Some of the relationships create feedback loops. These loops are reinforcing if the variables influence each other in the same direction. Loops are balancing if they influence each other in different directions. The thickness of the line denotes researcher’s emphasis on a relationship, for illustrative purposes. Dashed arrows highlight key, probable relationships identified through this study. The question mark (?) indicates an unknown relationship. This is not the recommended notation, as it is preferred to make explicit the “multiple causal pathways connecting the two variables” [33]. However, data currently do not exist to sufficiently tease out how dual practice affects service delivery. For example, while we know that dual practice can affect systems positively and negatively, whether and how much dual practice contributes to adverse service delivery outcomes is unknown.

Ethical approvals

Ethical approvals were obtained from the Institutional Review Board of the Johns Hopkins Bloomberg School of Public Health (IRB No. 4371), the Makerere University College of Health Sciences – School of Public Health Higher Degrees, Research, and Ethics Committee (IRB No. 11353), the Mulago Research Ethics Committee (Protocol no. 249), and the Uganda National Council for Science and Technology (Ref. No. SS 2883).

Results

Twenty-three interviews with doctors, nurses, and health managers from various types of facilities, as well as 13 policy-stakeholder interviews were conducted. None of the respondents approached for an interview declined to speak to us, although a few preferred that our interview not be recorded. Respondent characteristics are displayed in Table 2. About half of our health facility respondents reported having dual practice at the time of the interview, or having been previously been involved in private sector work.

The CLDs that follow display the factors associated with the presence of dual practice in the system and the emergence of current management practices and policies. They illustrate three phases to describe the emergence of dual practice in Uganda: pre-independence through the 1960s, 1970s through the 1980s, and the 1990’s through the present. Table 3 complements the CLDs by illustrating a timeline of critical events that affected the policy and management of dual practice.

The remainder of this section first describes, in each phase, the feedback and interactions that emerged in relation to government policies on dual practice, as well as, more broadly, the development of a mixed health system in Uganda. It concludes by describing how dual practice is currently managed in the government facilities included in this study.

Phase 1: Dual practice policy before Uganda’s independence and through the 1960s

Figure 1 illustrates a relatively simple system, showing no feedback or unintended consequences, where a nascent private sector does not initially provide sufficient incentives for providers to engage in dual practice.

During this time, government restrictions on dual practice are formal – written and enforced: dual practice is allowed only after government hours. Some dual practice opportunities exist, however, demand is low due to high satisfaction with the government benefits. Few government providers chose to engage in dual practice, generally seeking the autonomy provided by private practice. No evidence was found that dual practice raised concerns about adverse health service delivery outcomes. Even as restrictions on dual practice became stronger after Uganda’s independence, the Ugandan government was able to provide government health workers with sufficient financial and non-financial incentives (e.g., satisfactory wages and the prestige of working in a government institution, respectively). One of the policy-stakeholder respondents confirms the general sentiment in this period [32]:

“The assumption was, that what the government pays can cater for what you require in real life. [...] in the 60’s, a medical officer, medical assistant, the nurse, was capable of catering for everything they required, the basics of life [with the government salary alone]. And they were held with high esteem, they were very ethical. I mean a medical officer would walk with his head high.” – Ministry of Health policy stakeholder

Phase 2: Dual practice policy in the 1970s and 1980s

Figure 2, illustrates a second phase, during which the Ugandan system undergoes instability of military rule and, eventually, civil war.

During this period, instability affects the health workforce in multiple ways: through reduced infrastructure and government budgets, as well as through persecution of health providers for political reasons. These country-level hardships are intensified by the broader global recession. The multiple crises cripple the government health system, and mark the beginning of several decades of low government salaries. While the job security and prestige related to government service are still important, the government financial incentives are no longer sufficient for providers

Table 2 Interview respondent characteristics

Facility-based respondents		Case A	Case B	Case C	Case D ¹	Case E	Nr. (%)
Gender	Male	0	1	1	2	4	8 (35%)
	Female	3	2	2	1	7	15 (65%)
Yrs. in service	<10	1	1	1	0	0	3 (13%)
	10–19	0	1	1	0	5	7 (30%)
	20–29	2	0	1	1	2	6 (26%)
	30+	0	1	0	2	3	6 (26%)
Profession	Nurse	2	2	2	1	2	9 (39%)
	General practitioner	0	1	1	0	0	2 (9%)
	Clinical officer	1	0	0	0	0	1 (4%)
	Specialist	0	0	0	2	9	11 (48%)
Dual practice	Yes						10 (43%)
TOTAL							23
Policy stakeholders							
Gender	Male		12 (92%)				
	Female		1 (8%)				
Sector	Public/government		5 (38%)				
	Professional associations		4 (31%)				
	Private for-profit		3 (23%)				
	Private not-for-profit		1 (8%)				
TOTAL			13				

¹Years in service not available for one of the respondents at this facility.

who remain in the system. Many government providers resign at this time, or leave the country. Increasingly, government providers who remain in the system seek additional income through dual practice. The same policy stakeholder explained:

“[With] the economic downturn of the 70s, then the wars that have been associated with [Amin and Obote’s] regime, the salary did not have any meaning anymore. [...] The global economy has changed, impacting everyone, [...] the country, with all the hardships it’s had – the economy has not been able to cope with the many social needs. That’s why salaries across all public servants have remained very low and therefore public servants have to look for alternative survival mechanisms.” – Ministry of Health policy stakeholder

As the public sector increasingly suffers and government providers “look for alternative survival mechanisms”, this period leads to the first large-scale development of the private sector, after Asians (including doctors) were expelled from Uganda for political reasons, many of the Ugandan government doctors who remained in the country re-opened the former Asian private practices and many of them were perceived to have dual practice. At this time, the

increasing concerns about the quality of services provided in private for-profit medical practices (while not proven to be linked to adverse health and health system outcomes), contributes to suspicion around dual practice, specifically related to potential damage to the quality of services in the public sector and pilfering of government medical supplies. Consequently, the government begins imposing strong, formal restrictions on dual practice, a strict ban on dual practice and, at one point in 1972, closes all private clinics. As shown in Figure 3, these strong, formal restrictions to dual practice trigger provider protests and resignation, and contribute to provider migration, both of which compromise the supply of government health providers. International sanctions on the military government and a declining economy made salaries of civil servants unattractive. Increasing protests and advocacy from professional associations eventually lead to the government relaxing restrictions. Weaker restrictions, which allowed dual practice after government hours, reduced the threat to government providers and diminished the undesirable feedback.

During the 1980s, the global debt crisis and the subsequent structural adjustment program fuelled the development of the private sector, while, at the same time, constraining government budgets [34]. In this context, the financial benefits of working in private practice

Table 3 A timeline of critical events and government policy on dual practice

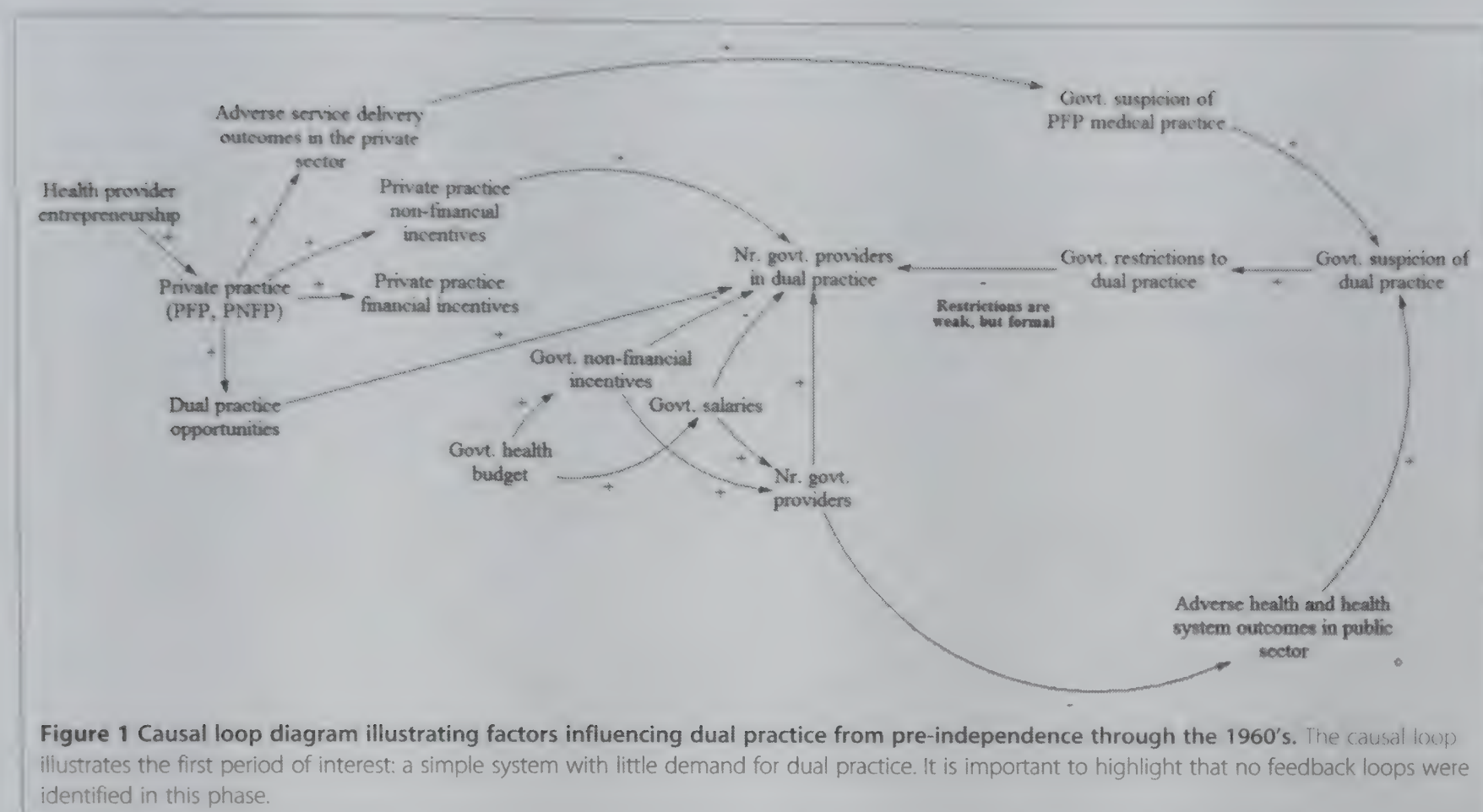
Year	Event	Dual practice policy	Consequences
Pre-	Nr. of African health professionals growing	Weak formal govt. restrictions: dual practice allowed after govt. hours	None
1962	Ugandan independence		
Post-1962	Govt. suspicions about private sector growing	Strong formal govt. restrictions: dual practice not allowed	No immediate effects
...	Transition to military rule and civil war		
1972	Asian doctors expelled		After 1970's events, restrictions to dual practice contributed to resignations from government services and provider migration – therefore reducing the number of govt. providers
...	Ugandan doctors take over private practices		
1974	Government shuts down private practices		
...	Provider protest advocacy to allow dual practice		
Late 1970's	Broadly, international sanctions on military government led to economic collapse and decline in government salaries relative to cost of living	Weak formal govt. restrictions: dual practice allowed after govt. hours	Dual practice is a coping mechanism for providers remaining in Uganda
	Government changes policy on dual practice as incentive for govt. providers		
1980's	Govt. suspicions about dual practice and private sector strengthen	Weak, formal govt. restrictions: dual practice not allowed	
1990's			
2000's	Rapid private sector growth, especially after system recovered from civil war, creates increasing nr. of dual practice opportunities	No formal govt. restrictions	
...		Informal govt. restrictions on dual practice, with weak influence	
2005–2007	MOH tests ban on dual practice in few hospitals		Providers threaten to resign
2009–2010	Office of President establishes Medicines and Health Service Delivery Monitoring Unit		Dual practice important coping mechanism
	Increasing nr. of policy discussions around dual practice, absenteeism, ghost workers		Providers threaten to resign in response to discussions of ban
	Increasing concerns about the contribution of dual practice to decreases in quality and access to care in both public and private sectors		

significantly exceeded those of the public sector, and motivated government providers to engage in dual practice. Government restrictions remain formal, but weak, at this time. Based on the available information, we propose that during this eventful and tumultuous period, dual practice and the incentives related to practicing in the private sector complement incentives for government service. Moreover, restrictions on dual practice without any further measures to address the government health system contribute to a decrease in the number of government providers. The dashed lines in Figure 2 highlight these proposed influences.

Phase 3: Dual practice policy from the 1990s to the present

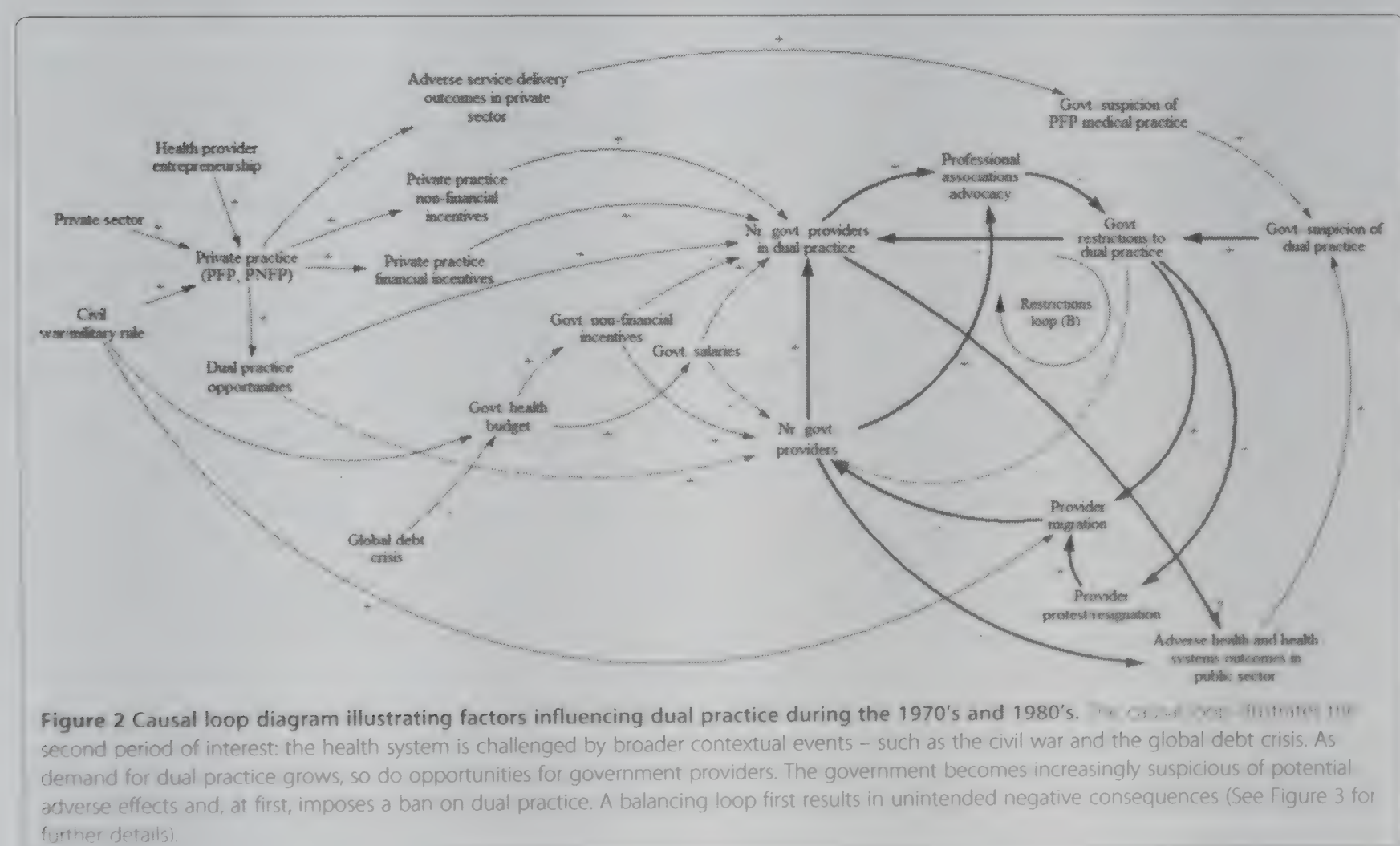
Figure 4 illustrates the changes in the system from the 1990s to the present: the private sector grows significantly as Uganda recovers from civil war and privatization is encouraged through the structural adjustment program [34] and well-financed vertical health projects and clinical research initiatives.

Dual practice opportunities grow quickly in a context of rapid private sector growth, as well as of increasing donor-funded research and NGO projects, generally housed within public facilities. Due to an ever constrained budget



and growing population demand, the government health system cannot offer providers an alternative to dual practice. Private practice during this period promises significant financial incentives, particularly in contrast to low government salaries, but lacks the job security

and prestige that are still associated with government practice. The increasing population demand, as well as the significant earnings possible through private practice, make dual practice a frequent coping mechanism for government providers. In the absence of formal rules to manage dual



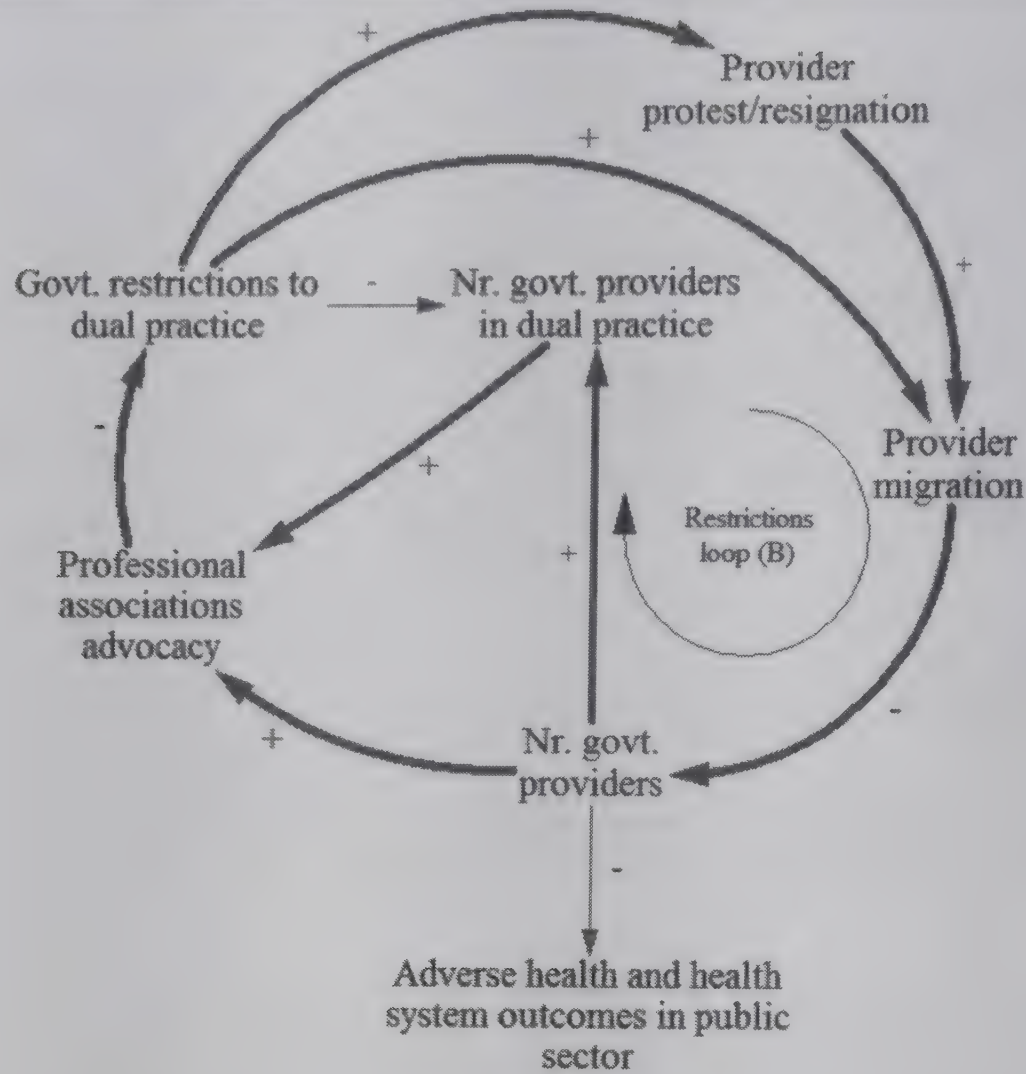


Figure 3 Focusing on the restrictions loop. Starting with the 1970's, strong restrictions to dual practice trigger unintended consequences through a balancing feedback loop – a decrease in the number of government providers. Subsequently, successful advocacy efforts to ease restrictions eventually dampen their effects on the broader health workforce, although restrictions remain in place they are acceptable to the provider population. This figure re-draws the CLD diagram to better illustrate the factors influencing these unintended consequences.

practice, health facility managers develop their own formal and informal practices for mitigating detrimental effects of dual practice, such as absenteeism, while retaining the government health workforce, despite low salaries and poor infrastructure.

The absence of a formal policy on dual practice was confirmed by interview participants and also by our review of Ministry of Health and Ministry of Public Service policy documents. As our respondents illustrate below, current government restrictions are informal – unwritten, not enforced, and based on expectations of provider behavior in the public sector.

"I don't think there is a clear policy saying that there is no dual practice [...] we are expected NOT to do it [...]. [Health workers] know what's supposed to be the normal, but are kind of forced to do it, as I've said, to improve a bit on their earnings. [...] We don't come out to fight it. I can't tell someone please don't go the other end, because there's a reason that is pulling this person to go, and I have no control over that. All I can do is to make sure enforcing that this person is here with me at the right time, for 7 or 8 hours. So we can't

influence what happens beyond that [...] I cannot influence the earnings. [...] The person has the needs, and I can't satisfy the needs in any other way [...] I can't provide alternatives." – Government official 1

"A lot of policies are implemented while they are just known by the policy-makers but they are not written down. So, we know about dual practice and the policy is that [...] it should be left as it is. That people can be allowed to do dual practice. [...] It is not written. It's not written at all, but they should not take too much of public time to do it. [...] Unfortunately, there is no mechanism to enforce how much public time people are going to take because [...] a lot of things that have gone wrong, including this dual practice, have gone wrong because of poor regulatory systems." – Government official 2

Interviews with policy stakeholders revealed that the government initiated periodic attempts to formalize government restrictions on dual practice, motivated by suspicion around dual practice due to media coverage of adverse health outcomes and poor public sector

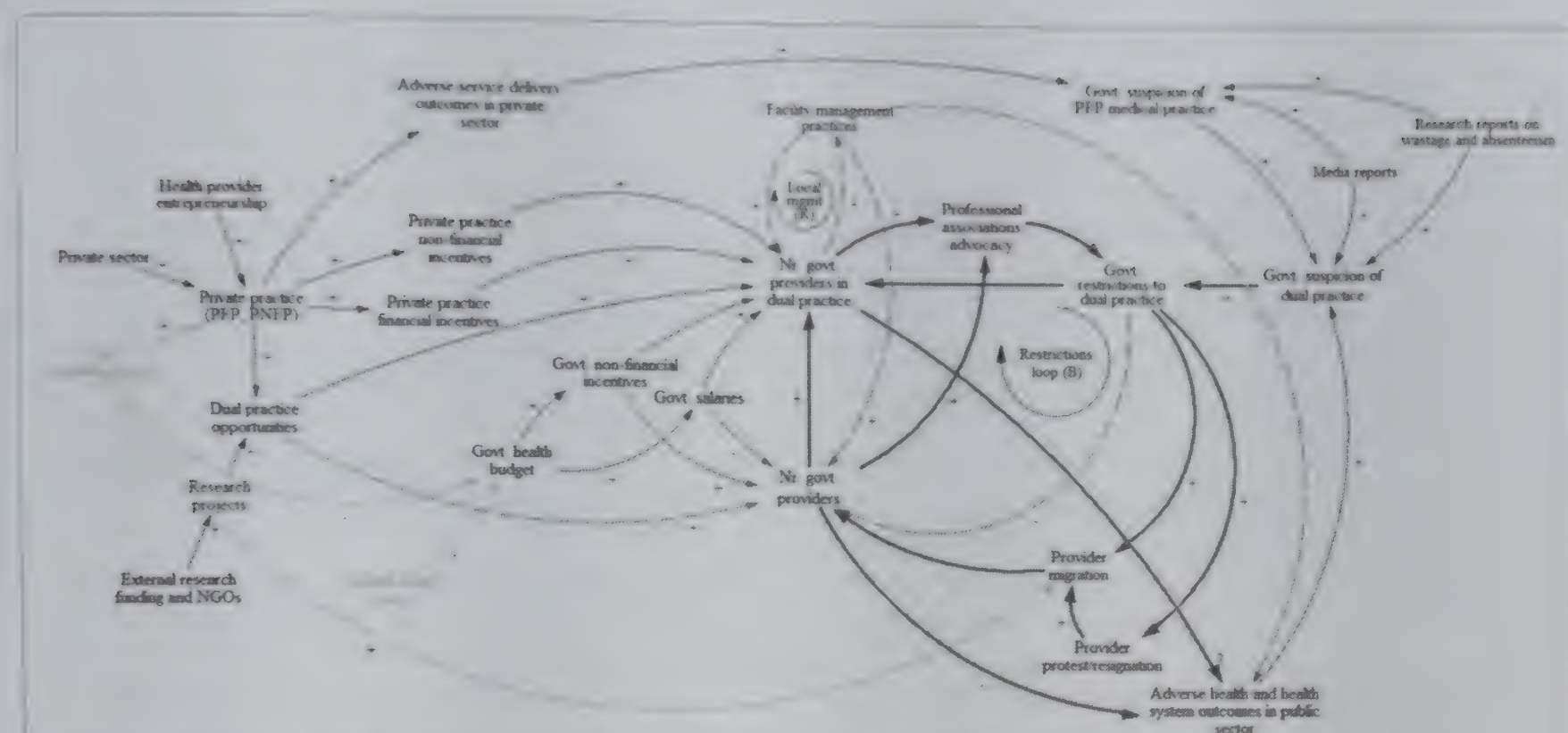


Figure 4 Causal loop diagram illustrating factors influencing dual practice during the 1990's to the present. Dual practice opportunities grow exponentially, as it becomes more attractive to government providers working in an underfunded and over-burdened public system. A formal, written government policy does not exist. Local facility-level coping mechanisms emerge to mitigate negative consequences of dual practice on the health system. Periodic threats for increasing restrictions re-activate the feedback loop presented in Figure 3.

performance. Additionally, restriction attempts are triggered in the context of budget discussions, media reports about ghost workers, and increased concerns about quality of care in both public and private sectors as indicated by adverse health service delivery outcomes linked to absenteeism, pilfering of drugs, and patient deaths in the private sector from suspected malpractice.

Escalating policy discussions around formalizing restrictions on dual practice are often met with provider protests, triggering the feedback displayed in Figure 3 and the government goes back to “keeping quiet”, in this case meaning informal restrictions. A couple of the policy stakeholders provides examples of such events, which also illustrate that the government increasingly recognizes the role of dual practice in the system, particularly in the absence of changing government pay.

~2005–2007: “The [high level official] gave a directive that it should stop. [...] He said: ‘Officer, we are going to work out the methodology of implementing it [...] But we shall not do it broadly across the country, we shall test it in some hospitals.’ So we came [to one of the hospitals], and communicated what the [high level official] had done, and said, these people [at this hospital] said: ‘We hear you loud and clear, but let’s agree if I cannot take that prescription, am I free to leave the government job? So that I can go to the other side [meaning private practice]? [...] we either stay or go? Is that what you’re trying to communicate to us?’ We said: ‘Yes’. Within two days [...] the [hospital]

director came rushing to the headquarters to say: ‘Guys, stop talking about dual practice because everybody is winding up to go.’ So, the [government official] went back and told the [high level official]: ‘We tried to test it in [a hospital] and all the consultants are not bothered - they want to leave [this hospital].’ - and dual practice has gone on.” – Ministry of Health policy stakeholder 1

In response to the cycles of uncertainty related to informal government restrictions to dual practice, as well as to coping with potential negative consequences of dual practice on public sector performance, we found that local, facility-level and department-level management practices can develop in government facilities. Facility management practices arise in response to increasing number of government providers with dual practice and aim to reduce any adverse service delivery outcomes in the public sector. As long as dual practice remains an incentive for providers to remain in government service (and sufficient resources to incentivize providers otherwise do not exist), these facility management practices could potentially weaken any policy restrictions to dual practice and any related negative effects on the government workforce.

Local management practices for dual practice

Data from the case studies revealed that, in the absence of a formal, written policy on dual practice, health managers develop their own approaches to coping with and

managing dual practice on a daily basis. Table 4 summarizes the approaches identified through this study. These facility-level management practices encourage the presence and performance of their staff during government hours although these codes of practice are generally unwritten. For example, no respondents described dual practice being addressed directly during regular staff meetings. Instead, respondents described informal, one-on-one consultations: health managers intervening with providers in private, often in response to an issue related to provider performance.

In one case, a health manager fostered a culture of flexible scheduling, i.e., all senior doctors get one day or certain afternoons to dedicate to their other activities, whether research or dual practice, in exchange for reporting to duty on other days. According to the unit's manager:

"We tried to create a bit of flexibility and say, ok, all of us must be on station in the morning, and let's take turns to cover the evening. And may be trying to bring the evening time a bit forward to, to allow people to earn some extra earning. [...] When I see the outputs, then I don't complain. Yes, and sometimes they come and start early, before 8 o'clock and if someone is here by 7 and even comes back on the weekend to clear if there is any backlog, I think, really, I can only say thank you because I can't pay them more than they earn." – Case E, Health manager

This particular arrangement was not only facilitated by the fact that the unit manager was understanding of the reasons why providers would engage in dual practice and had an output-oriented supervision style, but also by the fact that the majority of doctors working in this unit worked in the same private health facility, which was close to their government location.

Within the larger facilities, formal policies included, for example, having a private wing, where doctors and nurses could see and get paid for private patients under the auspices of the government facility, or limiting nurses' night duties so as to deter them from taking up full-time dual practice during the day.

Most of the health managers interviewed had a generally favorable attitude towards dual practice, not discouraging it within their facility. Their attitude stemmed from their own personal experiences where, in the past, they also had no choice but to take on additional jobs to compensate for government sector shortcomings. It also stemmed from broader frustration at not being able to enforce attendance policies and not having the necessary tools to adequately monitor health workers (an exception was the health manager for Case C, who expressed high confidence in public accountability). The principal tool available to managers for holding health workers accountable were

attendance registers, which could be easily falsified. In this context, dual practice was generally tolerated within government facilities. Health managers emphasized the need to prioritize the completion of government duties and, to the extent possible, tried to introduce incentives for improved performance in the public sector.

"I don't stop anybody from doing that. What [...] I tell them is that: priority is a core job and your core job is the public service. Once you do my work well, then I don't mind about what you do next." – Case D, Nurse/Health Manager

These management approaches, generally lenient with respect to dual practice, seemed to mitigate providers' exit from the government health workforce. Additionally, they also seemed to tackle broader issues of provider performance, such as absenteeism. In Case B, providers reported being able to manage their two jobs without conflict. One of the providers reported seeing dual practice as a privilege: *"if you want to reward yourself by doing an extra job, you have to make sure we [in the government sector] are covered"* (Case B, doctor). Nevertheless, because of the broader health system issues, where managers lack tools to properly enforce policies in general, approaches to manage dual practice also had shortfalls. For example, in Case C, the in-charge reported that providers who were found with multiple jobs (often caught in the private facilities), were asked to quit them in favor of government service. While this manager reported confidence in this approach, the other respondents from the facility reported that almost everyone in the facility engaged in dual practice, but this was not discussed with the manager. Some of these approaches also created tensions among staff. The flexible scheduling mentioned earlier was not available to non-physicians and therefore friction arose from time to time among work teams. The private wing is one of the dual practice policy interventions listed in the literature [15], however, in the study context, it was perceived to be inefficient, and the infrastructure only marginally better than the rest of the facility.

Discussion

This paper is one of the few contributing empirical evidence on dual practice policy and management practices in Uganda and low- and middle-income countries, more broadly. It illustrates how dual practice policies changed over time in the Ugandan system and how this phenomenon is currently managed within a sample of government facilities. It also attempts to use the existing data to reflect on and to explain why dual practice persists and the current approaches that have developed in the study context.

Table 4 Facility-level management practices for dual practice, by case

	Facility-level management practices	Attitude for dual practice	1-on-1 consultations	Discussion in staff meetings	Incentives/support supervision	Effect on the supply of government providers
Case A	Dual practice allowed after government duties completed	Negative	Yes	No	No	Associated misunderstandings potentially create feedback that decreases the supply of government providers. Providers interviewed had a different interpretation of the in-charge's version of "completeness," and reported leaving government work early. The misunderstandings associated with this approach were perceived to result in absenteeism
Case B	Motivate providers to perform at their public sector job (e.g., supportive supervision; tea, purchased in health manager's personal funds); non-interference with health workers' lives outside government duties	Cautious	Yes	No	Yes	Potentially promotes desirable feedback, by creating conditions to improve public sector performance and retain government providers
Case C	Discourage dual practice; emphasize priority for government duties and high public sector performance	Negative	Yes	No	No	Potentially promotes undesirable feedback by reducing the number of government providers; alternatively threats of disciplinary action could support improved performance in public sector
Case D	Priority for government duties; non-interference with time outside government duties	Positive	Yes	No	No	Potentially does not affect government supply of doctors, but creates tensions among staff Although the Case D – the smaller hospital's leadership had a positive attitude towards dual practice, they did not report a specific management strategy, except non-interference. Doctors reported to cope with dual practice through individual negotiations among their colleagues; however, this was not without pitfalls, as nurses were perceived to compensate for the absence of doctors. Furthermore, doctors appeared to have difficulty responding to emergencies, given that they juggled two or sometimes more places of work
Case E	Formal policies Policy preventing nurses to sign up for only night duties (which typically means they have a full-time day job) A memorandum of understanding with externally funded research projects, to stop the active recruitment of government staff to fill full-time positions on projects Private wing Informal policies None mentioned	Mixed, depends	Yes	No	Yes, in the context of flexible scheduling; N/A for other policies and practices	Potentially effective at reducing the number of nurses working two full time jobs. According to respondents, also improved attendance among nurses. Probably no effect on those with part-time dual practice Effective at reducing active recruitment by research and NGO projects, therefore reducing internal dual practice opportunities. According to respondents also improved attendance among nurses Ineffective – mild effect on government providers, but has potential if more efficient. Sustains retention among government providers, particularly specialists. Flexibility scheduling creates friction among non-physicians

Due to a series of health and non-health sector events, feedback, and learning, dual practice has become an informal, yet integral component of a government health workers' incentive package. This package has also evolved over time to one where job security and prestige remain important, but no longer sufficient due to some of the lowest salaries in the region, poor system infrastructure, and increasing patient loads. In a situation where the government cannot offer financial or non-financial alternatives to substitute dual practice (i.e., improve the incentives for sole public practice), the official policy for dual practice shifted from formal restrictions to one based on informal expectations. Any attempts to formalize restrictions is met with unintended consequences due to policy resistance and emerging feedback, threatening the stability of government health workforce more broadly.

Our data confirmed the existence of self-organization through local, facility-level management practice, which allow health managers and providers to cope with working in both the public and private sectors. The purpose of these practices was not necessarily to curb dual practice, but to maintain performance of the public sector by ensuring the presence of providers and, at the same time, to achieve an optimum balance between government workers' public and private activities and needs. Some of these management practices were easy to identify and describe, e.g., the ones guided by a health manager, as in the example of the hospital department. Other management practices, based on individual negotiations, presumably depended on internal provider networks, whose development, and also decline, could not be captured through our study methods. Most frequently, health managers found opportunities to intervene as common symptoms of dual practice that threaten public sector performance, such as absenteeism, triggered concerns. These management practices could potentially minimize destabilizing effects occasionally arising from the policy feedback and resistance.

Our exploration revealed two issues that are relevant beyond the issue of dual practice policy and management and perhaps also beyond the Ugandan context. First of all, public sector performance management emerged as an area with significant shortfalls. In the absence of tools and support for rewarding good performance and punishing poor performance, the tacit, indirect approach to managing dual practice does not sufficiently empower health managers to supervise and enforce boundaries for government employees, who must fulfill their duties in both the public and private sectors. Also, because the nature of dual practice differs among nurses, general practitioners, and specialists, cadre-specific management approaches and tools might be appropriate.

Second, the nature of the Ugandan health system, and that of many sub-Saharan African countries, is very

different than it was immediately after independence. Initially designed around the public sector, the private sector and particularly the private for-profit components, have been treated with suspicion and not integrated within a broader vision for the health system. Presently, the pluralist health systems that dominate low- and middle-income countries cannot be ignored. As a majority of the population, including the poor, relies on the private for-profit sector, increasing government stewardship is necessary to maintain the highest standards of service delivery [35]. In this context, providers engaged in dual practice could serve as a channel for reaching the private for-profit sector and the synergies between government practice and private for-profit practice must be recognized.

How dual practice actually affects the health system and service delivery remains one of the key unknowns. While the literature and study respondents acknowledged both positive and negative effects of dual practice, in most low- and middle-income contexts, Uganda included, actual effects on the health system are unknown. Furthermore, issues such as shortfalls in quality of care, absenteeism, and efficiency gaps in public spending have broader root causes and can only partly be attributed to dual practice. A better understanding of the dual practice effects on providers, health facilities, and the broad health system would help governments to better calibrate their policy approach and to explore options for reaching a better balance between public and private sector spheres in health care.

Strengths and limitations

This study represents one of the few exploring dual practice holistically, from multiple perspectives (doctors, nurses, managers, policy stakeholders), and by applying systems thinking tools, such as the CLD. Only a few examples of CLDs exist in health research [36-39]. The researchers established credibility and confirmability of the findings by triangulating the data from the interviews across multiple types of providers, and, where possible, through the document and policy review.

The conclusions are constrained by several limitations. Much of the early history of dual practice in Uganda relies on a single source and it was not possible to verify the events or written government documents we mention. Because the case studies were based in a large urban center, generalizations to rural Uganda, where the opportunities for private practice are substantially different, are not possible. We could not explore dual practice in private not-for-profit or for-profit facilities or include additional cadres believed to engage in dual practice (e.g., clinical officers). The large hospital was much more complex than the other cases included in our study, and perhaps deserved to be studied in greater depth. Although the information

presented in the CLD was triangulated across all available data sources, it could not be validated with study respondents as it was developed after the data collection ended.

Future research into how dual practice is managed by public facilities and how private for-profit facilities incentivize and contract with their providers, would be helpful. More in-depth studies looking at dual practice from the perspective of other cadres, such as clinical officers, or of rural practitioners could provide additional insights into this phenomenon. The facility-level management mechanisms described here could inspire formal policies aimed at minimizing the negative consequences of dual practice, while helping to seize opportunities for public-private sector synergies. The effects of dual practice on service delivery outcomes, such as quality of services and access to care, have not been established in the literature, although there is consensus that dual practice likely contributes both positively and negatively. Validating the CLD and translating it into a system dynamics model could be relevant in policy discussions as a platform for testing various policy scenarios and anticipating unintended feedback in the system.

Policy relevance

The unintended feedback revealed through the CLD, at times detrimental to the public health sector, confirms the recommendations of previous studies, which proposed that a ban on dual practice would not be practical or effective [14-16,40]. Periodic threats of banning dual practice also risk destabilizing the public health sector in places like Uganda, primarily by reducing the supply of government health workers. The private for-profit sector allows government providers the additional financial resources that the Ugandan government is currently not able to supply. In a relationship of mutual dependency, government providers in dual practice allow for the growth of the private for-profit sector in the context of limited health workforce and increasing population demand.

In the short term, the Ugandan government should consider the promotion of policies that are flexible to local adaptations to promote access and quality of services in the public sector, while at the same time allowing sufficient income for government providers. Informal, local adaptations to managing dual practice exist in Uganda and provide a natural experiment for various dual practice policies. In the long term, the Ugandan government should consider broader improvements to public sector management and increasing the resources available to the health sector, as well as increasing synergies with the private sector.

Reforms currently under discussion in Uganda include health insurance and performance-based contracts, both would change how providers are paid. Such reforms could

potentially provide an entry point for strengthening public sector management in general, and therefore provide health facility managers the tools they are currently lacking to manage dual practice. As dual practice is unlikely to disappear in the short term, its existence and role in the health sector cannot be ignored during the design and implementation of major health reforms in Uganda and other countries where dual practice exists. Potential unintended effects (feedback) should be anticipated based on past events related to dual practice and dealt with accordingly.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

This study was part of LP's doctoral dissertation. DP, SB, and FS were part of the advising and thesis committees, making important contributions to all phases of design, implementation, and analysis. LP prepared the first draft of the manuscript. DP, SB, and FS contributed to revisions and finalizing the manuscript. All authors read and approved the final manuscript.

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RESEARCH

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Advancing the application of systems thinking in health: understanding the dynamics of neonatal mortality in Uganda

Agnes Semwanga Rwashana^{1*}, Sarah Nakubulwa², Margaret Nakakeeto-Kijjambu³ and Taghreed Adam⁴

Abstract

Background: Of the three million newborns that die each year, Uganda ranks fifth highest in neonatal mortality rates, with 43,000 neonatal deaths each year. Despite child survival and safe motherhood programmes towards reducing child mortality, insufficient attention has been given to this critical first month of life. There is urgent need to innovatively employ alternative solutions that take into account the intricate complexities of neonatal health and the health systems. In this paper, we set out to empirically contribute to understanding the causes of the stagnating neonatal mortality by applying a systems thinking approach to explore the dynamics arising from the neonatal health complexity and non-linearity and its interplay with health systems factors, using Uganda as a case study.

Methods: Literature reviews and interviews were conducted in two divisions of Kampala district with high neonatal mortality rates with mothers at antenatal clinics and at home, village health workers, community leaders, healthcare decision and policy makers, and frontline health workers from both public and private health facilities. Data analysis and brainstorming sessions were used to develop causal loop diagrams (CLDs) depicting the causes of neonatal mortality, which were validated by local and international stakeholders.

Results: We developed two CLDs for demand and supply side issues, depicting the range of factors associated with neonatal mortality such as maternal health, level of awareness of maternal and newborn health, and availability and quality of health services, among others. Further, the reinforcing and balancing feedback loops that resulted from this complexity were also examined. The potential high leverage points include special gender considerations to ensure that girls receive essential education, thereby increasing maternal literacy rates, improved socioeconomic status enabling mothers to keep healthy and utilise health services, improved supervision, and internal audits at the health facilities as well as addressing the gaps in resources (human, logistics, and drugs).

Conclusions: Synthesis of theoretical concepts through CLDs facilitated our understanding and interpretation of the interactions and feedback loops that contributed to the stagnant neonatal mortality rates in Uganda, which is the first step towards discussing and exploring the potential strategies and their likely impact.

Keywords: Causal loop diagram, Child health, Health systems research, Methods, Neonatal mortality, Systems thinking, Uganda

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Background

With around three million babies dying each year within their first four weeks of life (neonatal period), virtually all (99%) occur in low- and middle-income countries (LMICs) [1]. Moreover, the most recent progress reports on global trends in neonatal mortality have shown alarmingly slow progress, if any, in curbing mortality rates among neonates, the slowest being in sub-Saharan Africa [1]. Three quarters of these neonatal deaths occur within the first week of life and at least 1 million die on the first day of life [1]. Uganda is one of the high burden countries in sub-Saharan Africa where the rate of decline in neonatal mortality has remained below the global average over the past 20 years, with an estimated 28 newborn deaths per 1,000 live births (a total of 43,000 deaths per year) in 2011 [1]. While child survival programs have tended to focus on pneumonia, diarrhoea, malaria, and vaccine-preventable diseases, all of these contributed to death after the first month of life. There is no documented progress in targeted approaches to prevent death around birth and the first week of life (Figure 1).

Several studies have tried to understand the reasons for this slow progress, employing a range of methods including logistic regression models [2-4], cross tabulations [5], principal component analysis, and simultaneous multiple regression models [6]. The vast majority of these studies focused on only one or a few aspects of the problem in isolation. Most notable were lifesaving interventions or key strategies geared towards improving access to, or coverage of, health services. Interventions that do not employ the holistic approach often focus on the symptoms neglecting the underlying root causes, thereby resulting in the reoccurrence of the problem. However, neonatal mortality is a very complex problem involving multiple factors and actors and requiring multiple interrelated and simultaneous strategies to be able to effectively address it, including the difficult challenge of changing attitudes,

perceptions, behaviour, and practices [7]. This complexity calls for employing more holistic approaches that acknowledge the complexity of neonatal health and of the health system itself, within which actions need to be taken, monitored, and managed.

Systems thinking provides a means to understand and work with this complexity. It aims to gain insights into the whole by understanding the linkages, interactions, feedbacks, and processes between the elements that comprise the whole system. In many cases, complexity stems from a combination of the complexity of the disease or condition itself (such as neonatal mortality) and the systems in which they are interacting and evolving, in this case the health system [8]. Health systems share the characteristics of complex adaptive systems [9]. They are constantly changing, tightly linked and governed by feedback, hence constantly coping and adapting to actions or changes in other parts of the system. They are history dependent and therefore often resistant to change and new directions, especially those initiated by the stewards of the system [10,11]. Therefore, intervening in the system almost always has ripple effects that affect other parts of the system and introducing change is often not as straightforward as the policy plans and design imply [11,12]. These are just a few of the reasons that argue for using a holistic systems thinking approach that takes into account this intricate complexity.

This study aimed to contribute to this timely debate by exploring: i) how systems thinking tools, more specifically causal loop diagrams (CLDs) [13,14] and system dynamics modelling [15-17], can help better understand the complexity underlying the factors influencing neonatal mortality, particularly in LMICs; and ii) what strategies and leverages may be successful in accelerating progress, using Uganda as a case study. The overall goal was to offer a comprehensive approach to examine the questions that can be applied in Uganda and can be adapted to other conditions, countries, and contexts.

Methods

This study employed the dynamic synthesis methodology (DSM). DSM combines two powerful research strategies, namely the qualitative (case study research method) [18-20] and the quantitative techniques (simulation models) [15-17], to provide solutions to problems. Figure 2 presents the DSM by Williams (2000) [21], later revised by Rwashana and Williams (2009) [13]. DSM has six stages, namely i) problem statement and preliminary data collection; ii) field studies; iii) model building; iv) case study and empirical exploration; v) simulation; and vi) policy analysis. This study applied the first three stages concluding with the development of a refined and validated CLD. The remaining three phases are underway and will be published subsequently.

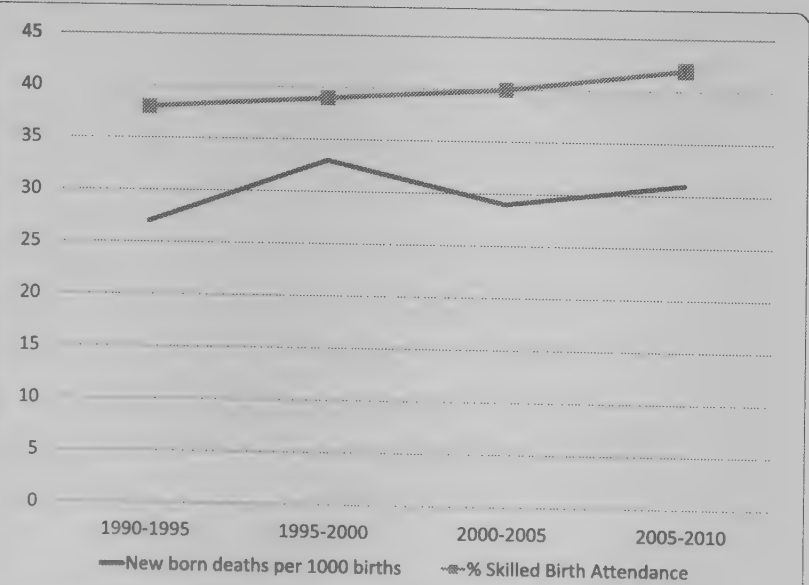


Figure 1 Trends in key neonatal health indicators in Uganda (1990–2010).

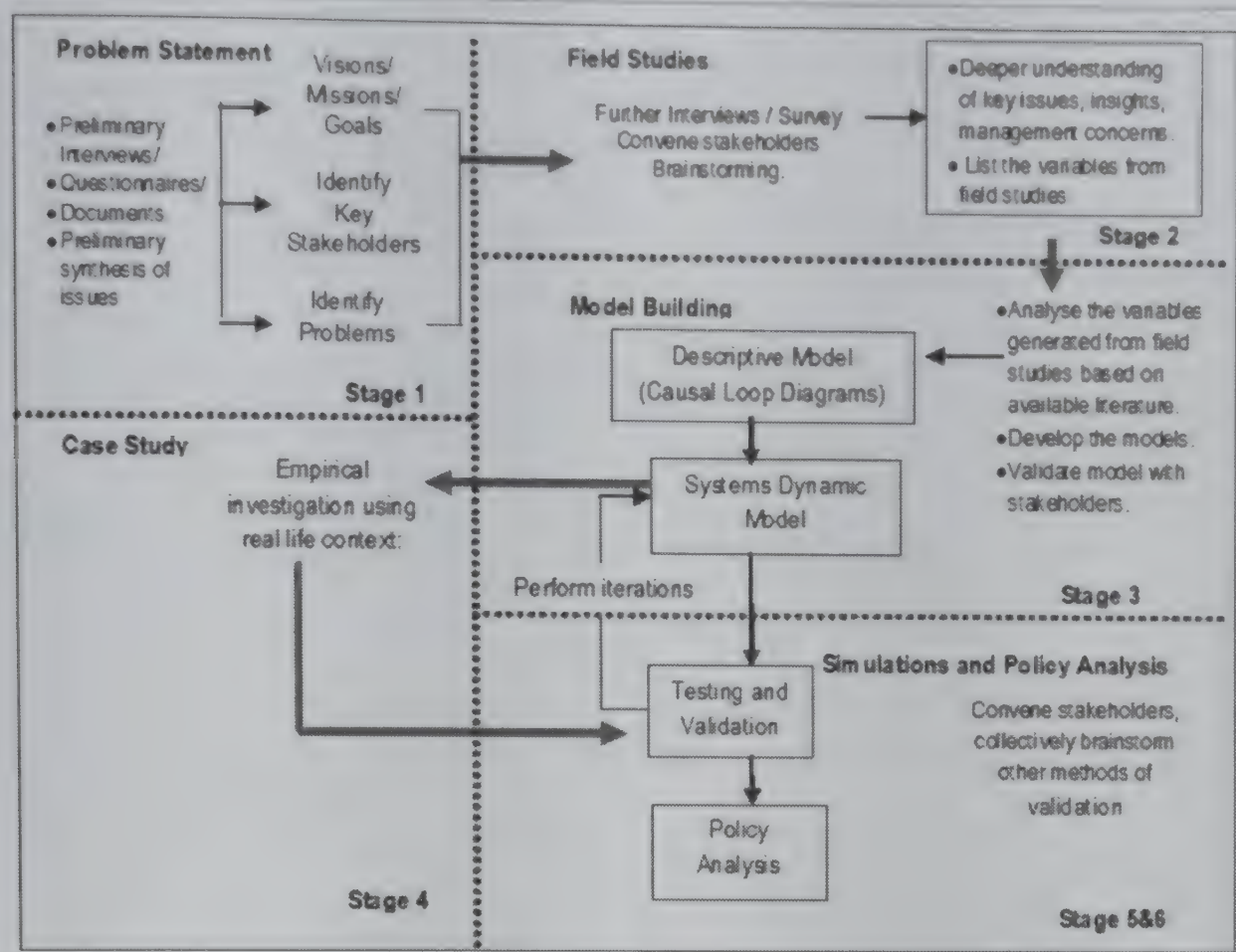


Figure 2 Research design: dynamic synthesis methodology. [Williams (2000) [21] revised by Rwashana and Williams (2009) [13].

Stage 1: problem statement

Preliminary information related to neonatal mortality and the associated problems was collected from peer-reviewed literature as well as global and local reports and policy documents in order to understand and better characterize the current problems influencing neonatal health. The collected data included historical trends of mortality rates and coverage of key related interventions, as well as information describing quality of care, perceptions, views, and attitudes of households and health workers in Uganda.

Stage 2: field studies

Semi-structured interviews were conducted with various stakeholders including mothers, village health workers, community leaders, front-line health workers at the first-level primary facilities and hospitals, and district and national policy and decision makers (see Additional file 1 for the data collection instruments). The purpose of the interviews was to explore the experiences, views, sources of information, and attitudes with respect to what happens during pre-conception, antenatal care (ANC), delivery and postnatal care (PNC). It also elicited insights on quality and management of health services for women seeking to be future mothers, pregnant women, and neonates. Interview guides were tailored to each type of respondent to cover the relevant range of questions. They were informed by the information gathered during the first stage and brainstorming among the study team of

other factors or problems that should be explored. They also allowed for exploring additional aspects or problems raised by the respondents through open ended questions.

Study population and sampling criteria

The interviews were conducted in Rubaga and Kawempe divisions of the district of Kampala, Uganda, where 47% of the population of Kampala reside. The Rubaga division was purposely chosen because it has two major mission hospitals that provide care for the low- and middle-income population from Kampala and nearby surrounding rural areas. Furthermore, Rubaga has the highest neonatal mortality rate of 54 per 1,000 live births in Uganda, compared to the national average of 27 per 1,000 [22]. The Kawempe division was chosen because it has the only national referral Hospital (Mulago) receiving referrals from all over the country. The sampling frame and selection criteria for the different interviews are presented in Table 1.

Mothers

A random sampling approach was used to identify mothers in antenatal clinics and from homes in the villages of Rubaga and Kawempe. At 95% confidence interval, a neonatal death rate (p) of 5.4%, and a level of permissible error (e) of ≤10%, the sample size was determined (see Additional file 2 for sample size calculation). The sample size was estimated as 282 mothers, divided equally between Rubaga and Kawempe (i.e., 141 each). In each division, 85

Table 1 Sampling frame and selection

Category	Sample size	Sampling approach	Criteria	Comment
Mothers	282	Random sampling	Mothers who delivered in the last 12 months residing in Rubaga and Kawempe divisions	Overall, 274 interviews were considered; 8 had significant missing information
Village health workers (VHWs) and community leaders	16 VHWs and 10 community leaders	Convenience sampling approach	VHWs and community leaders residing in Rubaga and Kawempe divisions	We stopped identifying new interviewees when no new issues were raised in the last interviews
Frontline health workers (FHWs)	20 FHWs (13 nurse/midwife/clinical officers and 7 doctors)	Purposive sampling inclusive of both government and private health units in the two divisions.	Officers-in-charge of the facility and/or health workers providing voluntary counselling and testing, or prevention of mother to child transmission services	One staff was interviewed from each available cadre/level
Healthcare decision and policy makers	7 leaders/policy makers	A purposive sampling approach.	Selected on the basis of their role in formulation and implementation of neonatal health policies	All the leaders/policy makers were interviewed

of the 141 mothers were sampled from health facilities and 56 from home. Mothers who delivered in the last 12 months and had consented to the study were included in the study, regardless of whether their babies were alive or dead. Mothers whose last child was more than 12 months old or was mentally ill were not included. Although the planned interviews were 282, only 274 interviews (Kawempe: 51 home, 88 health facilities; Rubaga: 55 home, 80 health facilities) were considered in the analysis. The remaining 8 interviews had significant missing information.

Village health workers and community leaders

A convenience sampling approach was used to select the respondents by selecting those residing in the villages where interviews with mothers and health workers occurred. A total of 16 village health workers and 10 community leaders from the villages of Rubaga and Kawempe were interviewed. We stopped identifying new interviewees when no new issues were raised in the last interviews.

Front-line health workers

Twenty front-line health workers were selected from Kawempe and Rubaga health facilities. The health facilities were purposively selected as follows:

- Kawempe: Mulago National Referral Hospital, one private hospital, Kawempe government health centre IV and three private health centres.
- Rubaga: Mengo hospital (mission hospital private not-for-profit), one private hospital, two private health Centres, and two government health centre III.

During the interviews with the in-charge of the facilities, health workers providing voluntary counselling and testing or prevention of mother to child transmission services were identified. Among the health workers who are performing these services, one staff was interviewed from

each available cadre/level, purposively selected in discussion with the in-charge. The total sample included 13 nurse/midwife/clinical officers and 7 doctors from public and private health centres and hospitals in both divisions.

Healthcare decision and policy makers

A purposive sampling approach was used to select 7 leaders/policy makers, on the basis of their role in formulation and implementation of neonatal health policies. These include two heads of the obstetrics and gynaecology departments of hospitals in each of the selected divisions; two neonatologists, one in a private and one in a public hospital; one district health officer, the person in charge of women and children issues at the district headquarters; one division health officer; and one ministry official involved in neonatal health.

Ethical consideration

Ethical approval was obtained from Mengo Hospital Research Review Committee and the National Council of Science and Technology of Uganda. Consent forms were prepared to protect and ensure the dignity and welfare of all participants, as well as those who may be affected by the results of the research project. All participants were asked to sign a consent form and were informed that participation was voluntary and that they could opt out at any moment. Anonymity was ensured by using study identification numbers and initials rather than names of individuals.

Mothers who were able to read and write filled in the questionnaire, while those who could not were interviewed. The socio-demographic characteristics of the mothers who interviewed for those are presented in Table 2. The age distribution, household income, and number of mothers who lost at least one neonate was similar to national average, while mothers' education, percentage that were housewives, and the number of

Table 2 Socio-demographic characteristics of mothers interviewed during the field studies in two divisions of Kampala District, Uganda, n = 274

Variable	Category	n (Percentage)
Age	15–20	49 (17.9)
	21–30	162 (59.1)
	31–40	59 (21.5)
	40+	4 (1.5)
	Total	274 (100)
Marital status	Married	209 (76.4)
	Not married	64 (23.2)
	Widowed/divorced	1 (0.4)
	Total	274 (100)
Highest level of education	None	9 (3.3)
	P1–P7	72 (26.2)
	Secondary education	140 (51.7)
	Post-secondary education	51 (18.8)
	Total	274 (100)
Occupation	Farmer	5 (1.8)
	Housewife/does not work	122 (44.7)
	Health worker	9 (3.3)
	Teacher	13 (4.8)
	Business woman	94 (34.1)
	Other professions	31 (11.4)
	Total	274 (100)
Household income per month (UGX) (1 USD = 2,500 UGX)	Below 50,000	34 (12.4)
	50,000–100,000	66 (24.1)
	Above 100,000	144 (52.6)
	Not indicated	30 (10.9)
	Total	274 (100)
Number of pregnancies	1–3	204 (74.4)
	4–6	63 (23.1)
	7+	7 (2.6)
	Total	274 (100)
Had lost neonate	Yes	18 (6.6)
	No	256 (93.43)
	Total	274 (100)

factors that contribute as well destroy the health of neonates; factors associated with the health service delivery in health facilities; and factors in the community and family that are associated with mothers’ attendance to health services.

We then used thematic analysis to compile and analyse the qualitative data. Descriptive statistics and cross tabulations were used to explore the quantitative data. SPSS 10.0 was used for these analyses [24]. Using the findings, we brainstormed and generated a list of potentially important variables that are associated with neonatal mortality, which was used to develop descriptive CLDs using Vensim Software [25]. The full list of variables considered for this analysis are presented in Additional file 3, which includes variables that were not considered in this analysis as well as evidence of association existing in the literature; this was not supported by our empirical findings for this case study.

Development of casual loop diagrams

CLDs help us to understand and depict the feedback mechanisms that are generated within complex systems which include the relationships, dynamics, and delays associated with the variables that generate them. They offer a practical way to understand and express the systems’ interrelated parts and the cause-effect linkages for the problem in question. CLDs are composed of two components; variables and influences (links). An influence has direction shown by an arrow and an indicator as to whether the influenced element is changed in the same (+) or opposite (–) direction as the influencing element. That is, a link from element A to element B ($A \xrightarrow{+} B$) may be positive if a change in A produces a change in the same direction, or negative ($A \xrightarrow{-} B$) if a change in A produces a change in B in the opposite direction. A change in element A which produces a change in element B only after a delay is denoted by $A \xrightarrow{||} B$.

Feedback loops occur when arrows connect a variable to itself through a series of other variables. There are two main types of feedback loops that can be expressed using CLDs: balancing and reinforcing loops, as illustrated in Figure 3. Balancing loops apply where there is an attempt to solve a problem or achieve a goal. They are also called neutralizing loops, where cause and effect cycles seek to counter a change with a push in the opposite direction. Figure 3 shows a balancing loop whose goal is to increase the mothers’ participation in health services. As more mothers participate in health services, the workload increases, thus increasing the waiting times resulting in frustration, which in turn lowers the participation. Reinforcing loops represent a growing action where each action adds to another and may be referred to as virtuous cycles when they produce desirable

pregnancies was closer to the urban rather than national rates [22,23].

Stage 3: model building and validation of the causal loop diagrams

First, we pooled the different sources of data from stages one and two and categorised these according to the following themes: factors associated with the mothers’ attendance to health services; social/personal characteristics associated with mothers’ attendance to health services;

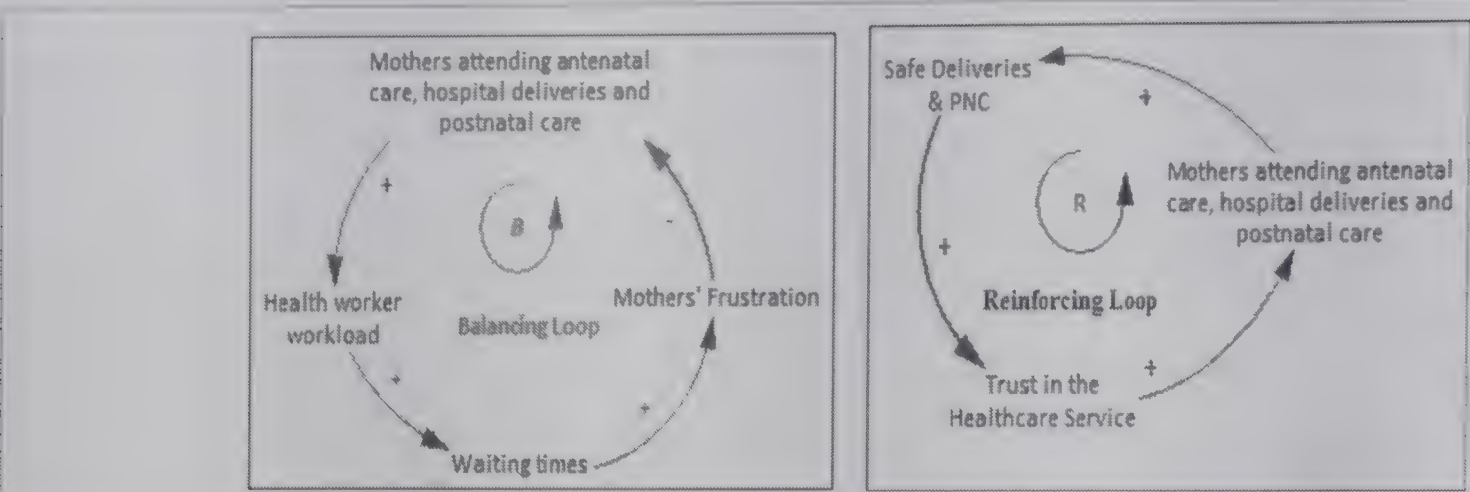


Figure 3 Example of balancing and reinforcing loops.

effects or vicious cycles when they produce negative effects. Figure 3 also shows a reinforcing loop where growing participation in health service arising from safe deliveries results in increased trust, which further increases participation.

Validation of the causal loop diagrams

Validation of the CLDs and the underlying conceptual thinking was carried out by nine local and international neonatal and maternal health stakeholders, including both researchers and implementers, as illustrated in Table 3.

Respondents were asked to state whether all the variables and relationships in the CLDs existed and whether there were any significant causal factors missing. In case there were some factors missing, they were asked to list them. In addition, respondents tested whether the directions of each of the links were right or needed to be reversed (implying that the effect is the cause) and were asked to state whether there were other effects that could be observed as a result of the causes in the CLDs. The validation instrument also included explanations of the objectives of the validation exercise, the meaning of the elements used in the CLDs, and how to respond to the questions; see Additional file 4 for the validation

instrument. Suggested modifications from the validation exercise were discussed by the researchers and used to further improve the CLDs together with further qualitative analysis of the collected data in response to questions raised by the validators, leading to the CLDs presented below.

Findings

Responses from all the interviews were categorized into demand and supply issues. The demand side captures the issues associated with the uptake of health services while the supply side shows the issues associated with the supply of health services. The key findings are presented in turn below.

Demand side issues

Pre-conception

Overall, 44% (8/18) of the mothers who lost their neonates suffered from diseases before pregnancy, including HIV, high blood pressure, malaria, sickle cell, and diabetes, among others.

Antenatal care

While 97.8% of the mothers in our sample attended ANC at least once, 25.9% of them attended fewer times

Table 3 Experts involved in the causal loop diagram validation (n = 9)

Position	Affiliation	Number
Head of Paediatrics Department	Mengo Hospital, Uganda	1
Obstetrician and Gynaecologist	Mulago Referral Hospital, Uganda	2
Lecturer, Department of Obstetrics and Gynaecology	College of Health Sciences, Makerere University, Uganda	1
Nursing Officer In-charge of Maternity Department	Mengo Hospital, Uganda	1
Head, Obstetrician and Gynaecologist	Mengo Hospital, Uganda	1
Paediatrician and researcher in maternal, neonatal, and child health issues	Universidad Peruana Cayetano Heredia and Universidad Nacional Mayor de San Marcos, Lima, Perú	1
Paediatrician/Professor	Department of Global Public Health and Primary Care, University of Bergen, Norway	1
Paediatrician/Neonatologist	WHO, Coordinator, of the maternal, neonatal and child research and development team	1

than recommended, providing the following reasons for failure to attend: lack of money for transport, busy work schedules, attending school, and delayed start of ANC clinic.

Delivery

The majority of the mothers (97.4%) were provided transport to the health centre for deliveries by the community (56.9% spouse; 17.2% relatives; 9.0% friends, and 3.0% neighbours). Only 13.1% used their money for transport.

Postnatal care

Some of the respondents lacked knowledge on how to care for the babies. For example respondents stated that they used vaseline, herbs, and powder for cord care. Some used breast milk, herbs, urine, water, and saline to care for swollen eyes.

Attitudes and beliefs

While almost all mothers (97.4%) in our sample gave birth at a health facility and believed in the importance of doing so, 40.9% stated that they knew of mothers in their community who did not go to health facilities for their deliveries. Cited reasons for why some of these mothers may have chosen not to go to health facility for their deliveries included traditional beliefs (14.1%), religious beliefs (3.2%), lack of permission from the spouse (3.8%), and lack of trust in the health system (14.7%). On the latter, more elaborations from the mothers included that they knew of mothers who feared that health facilities were poorly equipped, had insufficient health workers, were overcrowded with long waiting lines, lacked 24-hour care, had careless, rude, and abusive health workers who carried out excessive episiotomy, and that they found seeking care at health facilities to be very costly, possibly due to unavailability of drugs and lack of free supplies at health centres such as the Free Mama Kits for those who do not have their own.

Sources of information

Mothers stated that they generally obtain health information from various sources including radio, friends, brochures, films, health workers, family, and newspapers. With respect to information provided to the mothers during ANC, 92.8% of the mothers received information on HIV and the value of HIV testing, 84.6% on family planning, 84.3% on breast feeding, and 83.2% on nutrition (83.2%). When asked about what they thought were the best methods to encourage mothers to attend ANC and give birth at health facilities, they listed the following: home visits by health workers, village meetings, social meetings, community notices, and health education during ANC sessions.

Supply side issues

Quality of health service and hygiene

Although several mothers perceived hygiene at the health facilities to be generally good, 71% of the mothers reported that hygiene was still in need of further improvement. The surveyors also observed that some of the facilities were not well maintained and infection prevention was not well observed. Community leaders also noted that there were cases of neglect by health workers; one leader said “... *babies born with ... no one to wrap them*”.

Health workers motivation

All of the interviewed health workers mentioned that they were poorly paid. It was also observed by the mothers and the surveyors that staff experienced burnout due to workload arising from few skilled workers at the units resulting in a high provider to number of deliveries ratio. Health workers stated that both remuneration and safety measures at the health facility would increase their motivation. They also stated other demotivating problems such as electric power supply breakdowns during delivery, mothers losing a lot of blood before or after delivery especially where no blood bags were available, and difficulty in getting mothers to a referral hospital in case of emergency due to lack of ambulances.

Availability of supplies and equipment

Staff voiced frustration due to unavailability of the necessary equipment and supplies. According to our survey, 34% of health workers had deficiencies in resuscitation equipment and 67% lacked ultrasound facilities.

Record keeping

Only 16.8% of the health workers in our sample prepared births and death certificates and 83% kept Health Management Information System child health records and submitted them to higher levels; 50% of the village health workers reported that they lacked birth registers.

Policy enforcement

Community leaders and policy makers noted that some policies and guidelines were not readily available to the public and were not always adhered to. Only 33% of the health facilities had clinical guidelines available to them. For example, guidelines on cord care were not readily available. It was also noted by the policy maker at the district level that there was no clear policy and enforcement on recruitment of appropriate numbers of front-line health workers for the population.

Supervision

Overall, 18.8% of the village health workers reported that they were not supervised, which is consistent with

community leaders perceptions of gaps in supervision at the community level. Similarly, supervision of health workers at health units was also considered poorly enforced. In addition, community leaders voiced concerns about the number of unqualified people treating the population in their communities and that efforts to control this health risk should be strengthened.

Causal loop diagrams

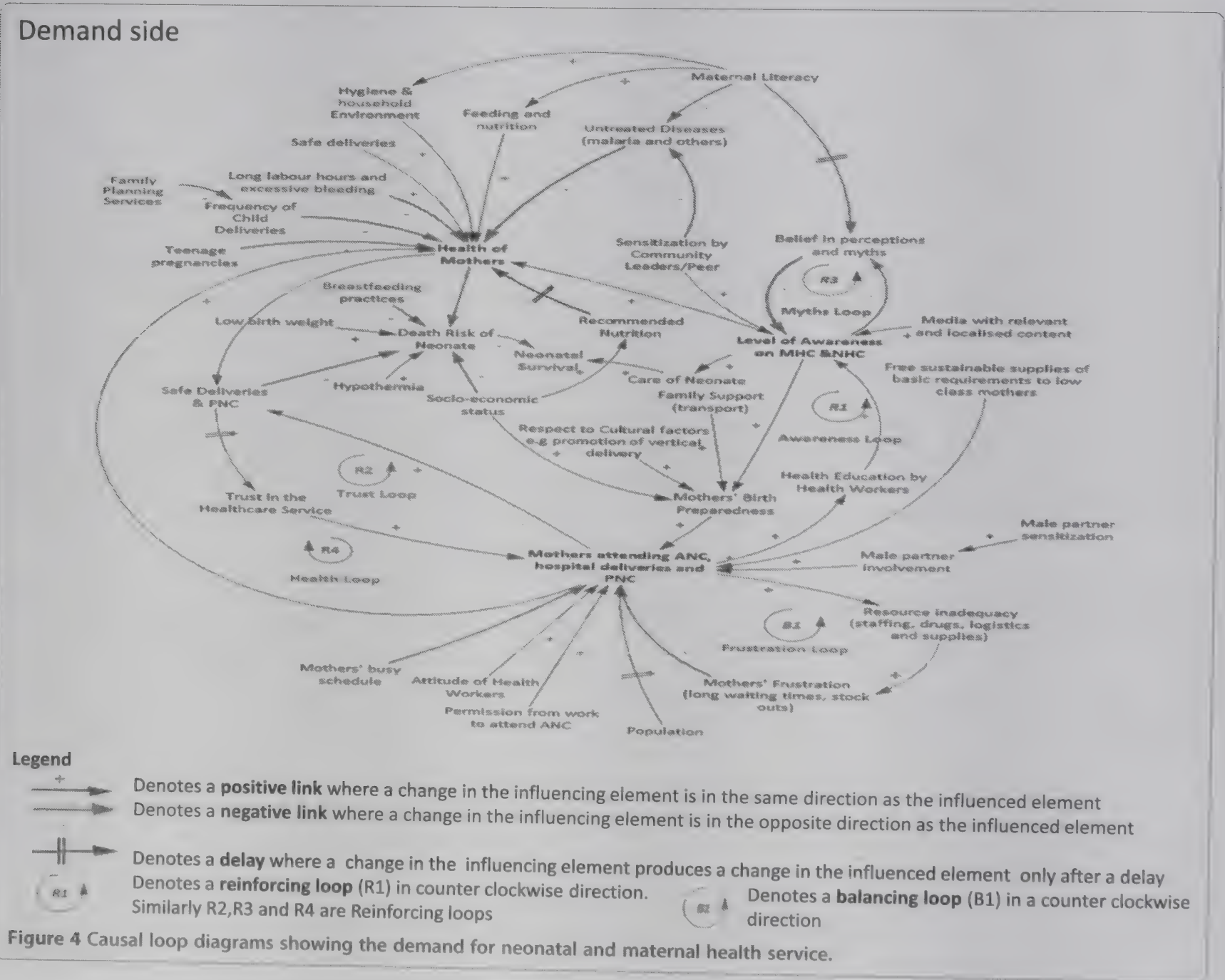
Two CLDs depicting the factors associated with the demand for (Figure 4), and supply of (Figure 5) health services for neonates and mothers were created from the interview and the data collection in stage one, together with brainstorming among the study authors. Several reinforcing and balancing feedback loops can be observed in these CLDs. A detailed analysis of the CLDs is provided below:

Dynamics of the demand for neonatal and maternal healthcare service

The dynamics involved in the demand for neonatal and maternal healthcare are presented in Figure 4. We

identified one balancing loop (B1, frustration loop) where there is an attempt to achieve the goal of increasing uptake of maternal health service and four reinforcing loops (R1, awareness loop; R2, trust loop; R3, myths loop; and R4, health loop) that represent growing actions as illustrated below.

The awareness loop (R1) is a virtuous cycle that enhances the growth of awareness. The level of awareness of neonatal and maternal health issues results in improved health of mothers and increased attendance to neonatal and maternal healthcare services, thereby lowering the death risk of neonates. Awareness is enhanced through health education programmes provided during ANC visits, media (TV, radio, newspapers), sensitization by community leaders, and word of mouth through peer to peer interactions among mothers. As mothers attend ANC, PNC, and hospital deliveries, the level of awareness increases resulting in mothers' preparedness for birth. Mothers' birth preparedness, which is achieved with increased level of awareness, family and community support, and socio-economic status increases the likelihood



Supply side

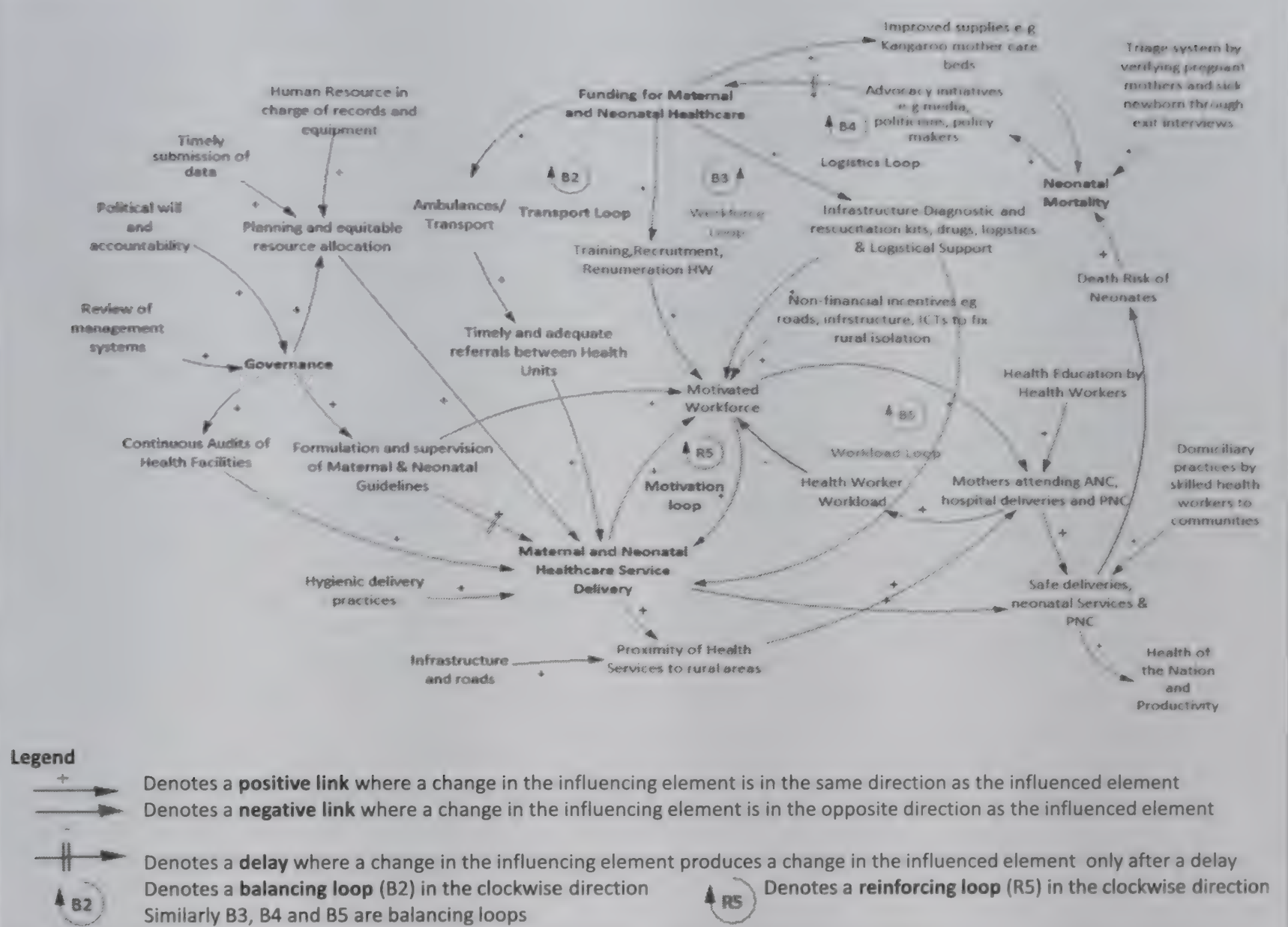


Figure 5 Causal loop diagram showing the supply of neonatal and maternal health service delivery.

of attending health services and therefore having safer deliveries, and further enhances the attendance to ANC. The growth in the awareness loop eventually slows down due to the inadequacy of resources exhibited in the frustration loop resulting into the limits to growth archetype (loops R1 and B1). In order to avoid the limits to growth, the quality of service in the health facilities must be sustained.

The trust loop (R2) enhances the trust of women in health systems through provision of safe health care deliveries and PNC. As more mothers attend ANC, hospital deliveries, and PNC, the level of safe deliveries and PNC increases, which in turn increases their trust in the healthcare service. The growth in the trust loop eventually encounters limiting action thereby exhibiting the limits to growth archetype (loops R2 and B1). The limits to growth of this cycle arises from inadequate resources that are needed to sustain the quality of maternal and neonatal healthcare service deliveries as exhibited in the frustration loop (B1) explained below. In order to maintain the trust, the quality of the maternal and neonatal service must be observed.

The frustration loop (B1) shows that the desired state is to have as many mothers attending ANC, healthcare deliveries, and PNC. Attendance to ANC and delivering at health facilities plays a big role in promoting safe deliveries and obtaining PNC, which will also contribute to increased trust in the health system and improving the general awareness about the benefits of these health services in the community. When the number of women participating in maternal and neonatal health services increases, the resources (staff, drugs, logistics, and supplies) in the health facilities are depleted, leading to frustration resulting from effects of poor service delivery such as long waiting times and drug stock outs, which results in a decrease in attendance, thus demonstrating a balancing loop. Efforts should be made to ensure that the resources in the health facilities match the demand, thereby minimising frustration of mothers.

The myths loop (R3) produces a desirable effect whereby beliefs in myths are decreasing. As the level of awareness on maternal health care (MHC) and neonatal health care (NHC) increases, belief in perception and

myths decreases. As the belief in perceptions and myths decreases, the level of awareness increases. Belief in myths and perceptions that are enhanced as a result of low maternal literacy levels are a hindrance to the level of awareness. Efforts to keep the growth of awareness through community and peer to peer sensitization, health education, and media should be made so that eventually the myths die off.

The healthy mothers loop (R4) produces a virtuous cycle where mothers' attendance to ANC and hospital deliveries results in improved mothers' health, thereby producing safe deliveries, which builds trust resulting in a further increase in the mothers' uptake of health services. This loop interacts with the frustration loop creating the limits to growth archetype.

The CLD shows that neonatal health heavily depends on the health of the mothers. The health of the mothers can be increased by increased self and household hygiene, increased level of awareness, attendance to ANC, PNC, and health facility deliveries, and adherence to the recommended nutrition. Factors that lower the mothers' health include increased frequency of child delivery, diseases such as malaria, and teenage pregnancies, among others. The death risk of a neonate increases with hypothermia, poor breast feeding practices, poor socioeconomic status, and poor care of the neonate resulting from lack of awareness.

Dynamics of the supply for neonatal and maternal healthcare service

The dynamics involved in the supply of neonatal and maternal health services are presented in Figure 5. In this CLD, one reinforcing loop (R5, motivation loop) that represents a growing action in the motivation of the workforce and four balancing loops (B2, transport loop; B3, workforce loop; B4, logistics loop; and B5, workload loop) all representing desired goals towards improvement in the supply of maternal health service are identified and explained below.

The transport loop (B2) emphasizes the importance of having timely and adequate referrals between hospitals towards improvement of the maternal and neonatal healthcare services, which can be achieved through the provision of transport/ambulances. As the funding for maternal and neonatal healthcare increases, provision of ambulances and transport increases, resulting in timely and adequate referrals between health units. This improves maternal and neonatal healthcare service delivery which lowers the death risk of neonates and in turn lowers neonatal mortality rates. A rise in neonatal mortality rates attracts an increase in advocacy initiatives resulting in increased funding. Funding for purchase and maintenance of vehicles as well as policies for use of these vehicles should be done.

The workforce loop (B3) shows that the desired state is to have a motivated workforce in terms of having the right skills, remuneration, and attitude. An increase in the funding for maternal and neonatal healthcare results in an increase in the training, recruitment, and remuneration of health workers, resulting in a motivated workforce. This improves maternal and neonatal healthcare service delivery, which lowers the death risk of neonates and in turn lowers neonatal mortality rates. A rise in neonatal mortality rates attracts an increase in advocacy initiatives resulting in increased funding. For this to happen, governments must be willing to fund and invest in the training, recruitment, and remuneration of health workers. Failure to do so eventually results in poor maternal and neonatal healthcare, thereby increasing the death risks of neonates and resulting in increased neonatal mortality.

The logistics loop (B4) shows that the desired state is to have quality maternal and neonatal health services where the health facilities have logistics, drugs, and resuscitation kits. As the funding for maternal and neonatal healthcare increases, provision of infrastructure, diagnostic and resuscitation kits, drugs, and logistics and logistical support increase. This improves maternal and neonatal healthcare service delivery, which lowers the death risk of neonates and in turn lowers neonatal mortality rates. A rise in neonatal mortality rates attracts an increase in advocacy initiatives resulting in increased funding. Governments should provide adequate funding to ensure that the required resources are made available.

The motivation loop (R5), together with the workload loop (B5), make up a limits to growth archetype. Limits to growth of this loop result from exceeding the capacity of mothers that can be handled by the workforce. The motivation loop shows that a motivated workforce that is well supervised, remunerated, and trained, and with adequate supplies will increase the maternal and neonatal healthcare service delivery. When the service delivery is good, this, in turn, further motivates the staff resulting in a virtuous cycle. The workload loop (B5), on the other hand, shows that an increase in a motivated workforce increases the number of mothers attending ANC, hospital deliveries, and PNC, which in turn increases the workload thus lowering the workforce that is motivated. It is therefore important that the health services and workforce are upgraded to meet the growing population which will even out the number of patients attending the few health facilities.

With adequate financing of maternal and neonatal health services, the following can be made available: training, recruitment, and adequate remuneration of health workers, resulting in a motivated workforce providing quality healthcare service and thus leading to safe deliveries; transport for timely and adequate referrals

between health units and obtaining blood bags if necessary; and equipment (e.g., for resuscitation, suction or oxygen), medical supplies, emergency drugs, and safe delivery kits. The availability of funding coupled with good governance is necessary for the formulation and enforcement of healthcare guidelines, planning, supervision, and efficient and equitable resource allocation, as well as monitoring and evaluation and audits of health facilities.

Although the graph in Figure 1 demonstrates that the skilled birth attendance has increased slightly there has not been significant decline in neonatal mortality rates over the past two decades. This clearly brings out the various limits to growth loops identified in the CLDs, which show that as the limits to growth are reached, the growth engine loses its effectiveness, and the growth curve begins to flatten.

Validation of the causal loop diagrams

Respondents used the validation instrument in Additional file 4 to test the CLDs. The validation process contributed to further modification and led to the final CLDs presented in this paper. The respondents were also asked to generally assess their experience with viewing the issues related to neonatal health by means of the CLDs. All the respondents saw and understood the CLD for the first time. The objective was to determine whether they found the CLDs to be reasonable, representative of the health-care issues, and whether they were useful aid and communication tools. See Table 4 for their perceptions.

Table 4 Overall impressions of the experts regarding the CLDs

Parameter	Rating categories	Number of respondents
Were they reasonable (realistic)?	Very reasonable	2
	Reasonable	6
	Fairly reasonable	1
	Not reasonable	
How well did they represent issues related to neonatal health services?	Very good	4
	Good	5
	Fairly good	
	Not at all good	
Are they useful as a communication tool?	Very useful	2
	Useful	6
	Fairly useful	1
	Not at all useful	
Are they a useful aid tool that can be used by stakeholders in decision making?	Very useful	3
	Useful	5
	Fairly useful	1
	Not at all useful	

Discussion

This study presents the first of its kind in-depth analysis of the possible causes of neonatal mortality in a given context with an explicit focus on complexity. We explicitly examined the feedback loops that were generated due to the complexities surrounding neonatal mortality as a first step towards considering and testing alternative short- and long-term strategies that may be used to efficiently address the root causes of some of these problems.

One of the main points of strength in this study is the inclusion of a wide range of perspectives of the different key stakeholders, including the mothers, front-line health workers, and village health workers. This undoubtedly enriched the analysis and provided a deeper understanding of the real causes of neonatal mortality and its interplay with the complexities of the health system it interacts with [9]. The second strength of this paper is using a validation instrument to validate the CLDs, which strengthened our model and its global relevance, given that we also approached international stakeholders from various regions of the world.

A limitation of this study is that it was undertaken in Kampala district. It is possible that there are other factors that are peculiar to other parts of Uganda such as the geographical environment (terrain), extreme poverty, and rural levels that have not been captured in this research. Our findings may, therefore, be more representative of urban Uganda than the whole country. However, this is only relevant for quantitative studies. The main objective of our study was to exploit the strength of qualitative approaches to explore how this problem, and its intricate complexities, can be understood in-depth, using a systems thinking approach. The objective of our study, therefore, included a methodological component and is not only relevant to neonatal health but to other diseases and settings.

The findings from the field studies suggest several short- and long-term strategies that would bear fruit in reducing the burden of neonatal mortality. For example, as shown in other studies [26], 44% (8/18) of the mothers who lost their neonates suffered from diseases before pregnancy. Ensuring that women in the age-bearing period receive adequate health education on their own health and its contribution to child outcomes prior to conception could, therefore, significantly increase the likelihood of detecting and addressing some of these problems, especially since several are preventable or treatable. The same applies for health education of postnatal health problems to avoid some of the harmful practices, such as those observed for cord care in our sample. Health education is also likely to increase coverage of ANC and deliveries at health facilities as reported by Uddin and Hossain [27] and Midhet and Becker [28]. For example, 97% of the mothers in our study visited

ANC at least once and more than 80% of them had good knowledge about the main health problems that are relevant to pregnancy and labour.

Our findings also highlighted the importance of supportive spouses and community involvement and its contribution to higher utilization of health services, especially for delivery, where the majority of the women (97.4%) received support by the community and only 13.1% used their money for transport. Our findings also highlighted health system problems that are standing against any possible improvement in neonatal mortality. These include the situation of health facilities in terms of hygiene and infection control, lack of cheap life-saving equipment and supplies, such as resuscitation kits, and suction machines.

Leverages

Leverages are influences within the system where small changes can effect a substantial change in the system. From the analysis of the CLDs, the following were perceived as high leverage points which can effect significant improvement in neonatal healthcare:

- Increased awareness on maternal and neonatal healthcare can weaken the vicious cycle exhibited by the myths loop (R3) while strengthening the virtuous cycle of the awareness loop (R1). Mothers' awareness on the recommended feeding, nutrition, hygiene, household environment, and mothers' birth preparedness and efforts to avoid untreated diseases results in improved health of the mothers, which in turn lowers neonatal mortality rates. Some of the short-term interventions which may improve awareness include aggressive advertising, campaigns, sensitization, and education of the women and girl child as well as increasing the effectiveness of the health education sessions during ANC and PNC. Special gender considerations to ensure that girls receive essential education thereby increasing maternal mortality rates is a longer term strategy but would synergistically address many other health and non-health issues.
- The low socio-economic status is a key determinant in the health of the mothers and the neonates. With improved socio-economic status, mothers are able to obtain the recommended nutrition, healthcare, and the requirements for birth preparedness. While introducing incentives, such as transport vouchers and free birth kits for pregnant women, would motivate them to attend ANCs and enable them to be better prepared for health facility deliveries in the short term, the government should work towards improving the socioeconomic status of the nation.

- Funding for maternal and neonatal health care should be prioritized at the national level. Efforts by the government and policy makers to upgrade the health service infrastructure as well as build systems for monitoring the resources (staffing, drugs, and stocks) would go a long way in minimizing the effects arising out of the frustration loop B1. Improved maternal and neonatal health service delivery will strengthen the virtuous cycle created by the motivation loop R5. In addition, without a motivated health work force that is well trained, adequately remunerated, and with an acceptable workload there is not much to be expected in terms of the quality of the care provided nor the likelihood that mothers will come to seek care at health facilities. Other short- and long-term strategies may include improved supervision and internal audits at health facilities to ensure that maternal and neonatal guidelines are adhered to as well as establish the current conditions and gaps in resources (human, logistics, and drugs) to guide the funding for national health care.

This study reports on stages 1–3 of our research design. Future work involves the completion of stages 4–6, where we will use empirical data to develop the quantitative (simulation) model including testing of different policy options. Iterations to test and validate the model will be conducted through brainstorming sessions with stakeholders. What-if analysis will be used to test different strategies that have been suggested by this research and by stakeholders, including policy makers, during brainstorming and validation workshops with the aim of improving policy analysis and design in neonatal health. The model will be used to determine the strategies that could have a great impact on neonatal mortality using sensitivity analysis.

Conclusions

This study adopted a systems thinking approach to capture and analyse the interactions between technical, policy, behavioural, and cultural issues related to neonatal mortality. It provides a broad integrated view of the dynamics associated with neonatal health, thus accommodating the different stakeholder viewpoints. The synthesis of the various theoretical concepts through the use of CLDs facilitated the understanding and interpretation of the different interacting elements and feedback loops that contributed to the stagnant neonatal mortality rates in Uganda, which is the first step towards discussing and exploring the pros and cons of the different strategies and the priorities that should be addressed based on their likely impact and cost-effectiveness.

This paper also illustrated the importance of validation of the structure and relationships of the CLD with key stakeholders, including decision makers, which was beneficial, enriching, and ensured that the variables of the CLDs represent that of the real system. The validation exercise demonstrated that CLDs can help the different stakeholders view complex health problems from different perspectives and facilitate shared understanding and common ownership of the interpretations of health problems. They also provide a broad integrated view of the problems which can be used for learning and process improvement, as well as operational management. The methods, approaches, and findings from this study are not only applicable to neonatal health and Uganda, but also to other settings and questions of a similar nature.

Additional files

Additional file 1: Data collection instrument.

Additional file 2: Sample size calculation.

Additional file 3: List of variables.

Additional file 4: Causal loop diagram validation instrument.

Abbreviations
ANC: Antenatal care; CLDs: Causal loop diagrams; DSM: Dynamic synthesis methodology; LMICs: Low- and middle-income countries; PNC: Postnatal care.

Competing interests
The authors declare that they have no competing interests.

Authors' contributions
ARS conceived the paper, developed the study design and data collection tools, analysed the data, developed the CLDs, and drafted the manuscript. SN and MNK contributed to the study design and data collection and analysis and the interpretation of the results. TA contributed to formulating the study design, data collection, interpretation of the results, and of drafting the manuscript. All authors reviews and approved the final version.

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RESEARCH

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Advancing the application of systems thinking in health: understanding the growing complexity governing immunization services in Kerala, India

Joe Varghese^{1*}, V Raman Kutty², Ligia Paina³ and Taghreed Adam⁴

Abstract

Background: Governing immunization services in a way that achieves and maintains desired population coverage levels is complex as it involves interactions of multiple actors and contexts. In one of the Indian states, Kerala, after routine immunization had reached high coverage in the late 1990s, it started to decline in some of the districts. This paper describes an application of complex adaptive systems theory and methods to understand and explain the phenomena underlying unexpected changes in vaccination coverage.

Methods: We used qualitative methods to explore the factors underlying changes in vaccination coverage in two districts in Kerala, one with high and one with low coverage. Content analysis was guided by features inherent to complex adaptive systems such as phase transitions, feedback, path dependence, and self-organization. Causal loop diagrams were developed to depict the interactions among actors and critical events that influenced the changes in vaccination coverage.

Results: We identified various complex adaptive system phenomena that influenced the change in vaccination coverage levels in the two districts. Phase transition describes how initial acceptability to vaccination is replaced by a resistance in northern Kerala, which involved new actors; actors attempting to regain acceptability and others who countered it created several feedback loops. We also describe how the authorities have responded to declining immunization coverage and its impact on vaccine acceptability in the context of certain highly connected actors playing disproportionate influence over household vaccination decisions. Theoretical exposition of our findings reveals the important role of trust in health workers and institutions that shape the interactions of actors leading to complex adaptive system phenomena.

Conclusions: As illustrated in this study, a complex adaptive system lens helps to uncover the 'real' drivers for change. This approach assists researchers and decision makers to systematically explore the driving forces and factors in each setting and develop appropriate and timely strategies to address them. The study calls for greater consideration of dynamics of vaccine acceptability while formulating immunization policies and program strategies. The analytical approaches adopted in this study are not only applicable to immunization or Kerala but to all complex interventions, health systems problems, and contexts.

Keywords: Causal loop diagram, Complex adaptive systems, Governance, Immunization, India, Kerala, Systems thinking, Trust, Vensim

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Background

Organizing immunization services to protect the society against preventable diseases is a core function of public health. In India, the Universal Immunization Programme (UIP) introduced in 1985, targets 27 million infants and 30 million pregnant women every year and is one of the largest in the world [1]. Though UIP has improved the availability of vaccines and cold chain management compared to earlier immunization programs, the system has not yet achieved sustained improvement in vaccination coverage in many Indian states [2,3]. It has been slated as a mechanistic approach, which was simplistically expected to improve immunization coverage through the improvements in health infrastructure, financing, supplies, and better management practices [4,5]. This approach has typically failed to account for the unique characteristics, interactions, and needs within local systems and the diversity of actors impacting a household's decision to vaccinate. Such an approach was often constrained by a lack of understanding of the complex behaviour of local health systems, which often do not respond as expected to external interventions and policies. Furthermore, such an approach can only provide a limited explanation for fluctuations in immunization coverage rates, over time.

This paper describes an application of systems thinking to understand the complex phenomena underlying

changes in vaccination coverage in India. Specifically, this study seeks to use a complex adaptive system (CAS) lens to understand the features of a complex system that governs childhood immunization in parts of the Indian state of Kerala, where immunization coverage drastically declined after a period of high coverage.

Kerala holds a special place in the global public health discourse for its remarkable health achievements despite low economic status [6]. Unlike the national average of full immunization coverage (of BCG, Polio, DPT and measles) of 54.2%, Kerala had achieved over 84% in the late 1990s before starting to decline in subsequent years (Figure 1) [7]. This decline mostly involved the northern districts of Kerala. The reduction of coverage in northern districts in Kerala is a concern for public health authorities as it negates herd immunity that protected communities against the potential spread of vaccine-preventable diseases [8,9]. The sudden decline in immunization coverage, in a state where vaccines were uncritically accepted as a social good in the past, has puzzled public health officials and experts [10].

Theoretical underpinnings

Our study adopted a CAS-lens for exploring the factors that influenced immunisation services in Kerala and identified many characteristics of the CAS phenomena

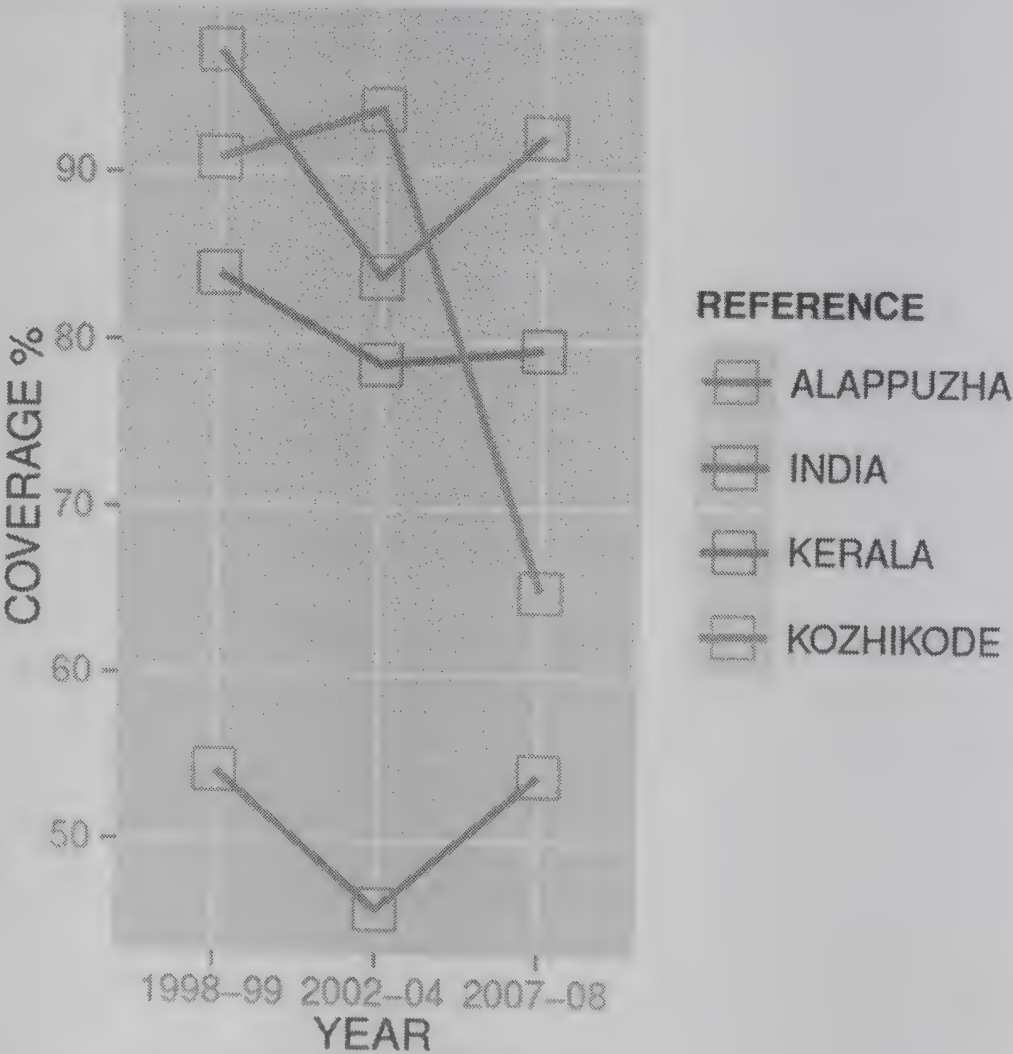


Figure 1 Changes in vaccine coverage in Alappuzha and Kozhikode districts of Kerala.

in the discussion. CAS exhibit the capacity to self-organize, adapt, and learn from past experiences, which often results in counterintuitive and unintended effects or paradoxical behaviour [11,12]. CAS may exhibit various unique features, such as path dependence, feedback loops, scale-free networks, emergent behaviour, and phase transition.

Path dependence refers to non-reversible processes that have similar starting points yet lead to different outcomes due to different choices made along the way. Feedback loops that feed into the system explain how small changes can grow into large consequences that can be 'reinforcing' a particular outcome or may lead the system to go back to an original state, what is called 'balancing' or goal-seeking loops. Phase transitions occur at tipping points when systems show sudden changes even without any additional inputs. Scale-free networks refer to the formation of influential hubs that can shift the focus and power of networks by exerting higher influence on other actors in the network through their multiple interconnectedness, hence activating a change in behaviour. CAS can also exhibit emergent behaviour when smaller entities jointly create a spontaneous order and show organised behaviour.

In the context of the governance of public health interventions, such as immunizations, complexity is generated from the diverse and dynamic nature of interactions between the system's actors and the multiple interacting factors such as values, culture, history, norms, and distribution of power and information in societies. Furthermore, the interconnectedness between the various actors of the system means that their actions inevitably create ripple effects that cause continuous change and adaptation of the intervention in the entire system [13].

Exploring these complex system features in Kerala will shed light on the factors that drove the unexpected changes in immunization coverage and will provide insights into the types of system adaptations that must be considered by national immunization programs.

Methods

A qualitative case study design was used to obtain an understanding of immunization coverage in Kerala. The data used in this paper originated from a larger study seeking to understand the governance of immunization in two states in India [14]. Initial findings from this earlier study highlighted the need to further explore the complexity of immunization services in one of the states – Kerala – where we observed surprising trends in immunization coverage (Figure 1).

Two districts in Kerala were randomly identified from high and low coverage districts in the state [7]. The districts were Alappuzha, a better performing (90.2%) district in terms of immunisation coverage as per the third District Level Health Service survey, and Kozhikode, a

poor performing (65%) district. In each of these districts, better performing and poor performing areas in terms of immunisation service were identified with the help of district level managers. Though the difference in immunization coverage between two areas within the districts was marginal, the identification of different locations helped in collecting information from diverse contexts. From each area, two primary health centres and a private health facility were selected for observation of the immunisation services and interviewing the practitioners.

The main data sources included a literature and document review (including news reports), in-depth interviews, focus group discussions, and observations of immunization services. All data collection was undertaken by the first author in Malayalam (local language), over a period of six months during late 2009 and early 2010.

In each district, in-depth interviews were carried out with immunization service providers from public and private sector, those who facilitate vaccination, such as community health workers, and those who opposed it. We used a snowball sampling method, whereby, at the end of the interview, the respondent's suggestion was asked about other important stakeholders in order to identify the next respondent. The experts interviewed were also identified using a snowball method based on their research experience on immunization or their expertise of immunization service, either as a past or present state or district level immunization program implementer.

Focus group discussions were undertaken with mothers of children below five years of age and one with the health workers of one of the primary health centres. The mothers were identified and invited with the help of community workers and the discussions were arranged in one of the local houses or local Anganwadies (pre-school and nutrition centres for women and children). The number of participants per focus group discussion varied from 7 to 10.

Participant and non-participant observations were made with the help of an observation guide in order to gather insights into cultural meanings and interpretations related to provider and beneficiary behaviours and context. All participant observations were made during the house visits that the first author made along with community health workers, aiming to mobilizing beneficiaries for vaccination. During each of the visits the researcher was introduced to households as a public health researcher and was involved in motivating and educating the families on childhood vaccinations. In most of the households visited, the initial communication related to vaccination was provided by the community health worker and the researcher was asked to clarify when further explanation was required. For participant observation, the researcher had to play the role of a public health expert and researcher simultaneously. This involved active engagement in mobilizing the parents for immunization of their

children along with making qualitative observations from this engagement for the research. Non-participant observations were made during immunisation sessions at health facilities, outreach immunisation sessions, and review meetings of field staff in charge of the immunisation programme. Important observations were noted onsite and, at the end of the day, a full record of the field notes was prepared by appropriately commenting on each of these activities.

All interviews and focus group discussions were digitally recorded, transcribed, and translated into English. Content analysis was applied to the transcripts of interviews and focus group discussions, as well as the field notes of observations [15]. The various categories for content analysis, as informed by the application of a CAS lens, were identified prior to the analysis. Using these categories, we used a deductive coding of the data. Atlas.ti ver.7 was used for arranging the text according to codes and managing the codes in the interpretive phase.

The three different methods were used for data collection from various types of respondents; observation, interviews, and focus groups involving various sources of information helped in triangulating the findings. In order to reduce the subjective bias of the first and second authors due to their prior information of the functioning of Kerala's health system, a peer scrutiny of the analysis was done by the third author who assessed the assumptions made.

Based on the qualitative data analysis, a causal loop diagram (CLD) was developed using Vensim PLE [13,16]. CLDs are qualitative representations of underlying mental models and are typically used to illustrate feedback and interactions among health system actors [17]. For this study, the purpose of the CLD was to assist in the identification and interpretation of the feedback loops that emerged in the context of immunization. The CLD was also used to guide the brainstorming discussion among authors about other complex phenomena that governed the analysis period. The variables used in the CLD were derived from the qualitative data, as well as from the literature on determinants of immunization coverage. The CLD uses standard notation, where positive arrows denote that two variables change in the same direction, and negative arrows denote that two variables change in opposite directions. An arrow with a double hash mark on it (||) indicates that there is a time delay in the relationship denoted. Reinforcing loops, which indicate that variables have an overall amplifying effect, are labelled with an "R" and a loop symbol. Balancing loops, which indicate that variables have an overall dampening effect, are labelled with a "B" and a loop symbol. The loop symbol is either clockwise or counter-clockwise, depending on the direction in which the loop is read [17]. Where there were multiple loops, we numbered them in the order in which they appear in the text. We used the CLDs not only as a summary

of the content analysis, but also to conceptualize and develop additional potential linkages between factors. Dotted arrows have been used to denote those potential additional relationships that were not empirically explored.

The study protocol was reviewed for ethical and technical clearance by the Institutional Review Board (Sree Chitra Tirunal Institute for Medical Science and Technology, Thiruvananthapuram, India). Written permission for data collection was obtained from state level health officials as well as from district level officials and participation in the study was made voluntary by ensuring informed consent from all participants and the possibility to withdraw at any time. All identifiers of the study participants from the transcripts of the data were removed by the first author to ensure anonymity of the study participants.

Results

The fieldwork included 7 participant and 7 non-participant multi-site observations, 5 focus group discussions, and 17 interviews with beneficiaries, community intermediaries (community health workers, nutrition and pre-school teachers and community leaders), and providers from public and private sector. The study also involved key informant interviews with 6 experts.

As described in the introductory section, our analysis of trends in immunization coverage in both districts showed a sudden decline in immunization coverage in Kozhikode; based on three rounds of the District Level Household and Facility Survey, Kozhikode showed a decline after the second round of the survey in the 2002–2004 period. The full immunization coverage in Kozhikode district in northern Kerala dropped from 94% (2002–2004) to 65% (2007–2008). During the same period, the coverage in a southern district, Alappuzha, had in fact gone up from about 84% to around 92%. The decline in immunization coverage in Kozhikode is, in fact, a reversal of the trend from the earlier period between the first (1998–1999) and the second survey (2002–2004), which showed improvement in vaccination coverage.

The qualitative data showed a widespread hesitancy against routine vaccinations in Kozhikode district, while routine vaccinations are widely accepted in Alappuzha district. It was also observed that the resistance against vaccination was often limited to geographical locations. It was observed during the house visits in vaccine-resistant areas of Kozhikode district that most of the unvaccinated children are found in households of close geographical vicinities. The differences in immunization coverage in different areas within Kozhikode district is explained by the spread and extent of vaccine-resistant geographical locations within the district. However, we could not elicit major differences in vaccine acceptability between high and low coverage areas of Alappuzha district, which

may be explained by other factors such as poor socio-economic status of the region, absence of public health human resources, or anomalies in the reporting of vaccination coverage.

In the following section, we first illustrate the feedback loops that emerged as a result of interactions among the key actors and contributed to phase transitions from vaccination acceptance to resistance. We introduce two separate CLDs that are relevant to the acceptability phase and vaccine-resistance phase to discuss the contrasting features of these two phases. We also describe the feedback that affected the districts differently after showing a high level of vaccine acceptability in the beginning. Next, we show how the authorities have responded to this problem of decline in immunization coverage and discuss the impact of their response in the presence of certain highly connected actors playing a disproportionate influence over a household's vaccination decision.

Phase 1: Acceptability

As mentioned in the introduction, the UIP heralded a shift compared to earlier programs in both the availability and acceptability of immunizations in Kerala. After a decade of implementation, society perceived vaccines to be effective in the prevention of certain diseases and coverage increased significantly. Figure 2 displays the CLD illustrating the factors promoting the acceptability of immunization under UIP. There were several actors who contributed to this. Public allopathic doctors were important sources of health education and encouraged immunization. Private sector allopathic doctors also contributed to this effort either in collaboration with UIP or through their independent efforts. A large part of the success of the UIP program during this period was credited to the joint efforts of health field workers and anganwadi workers (A/W). These two groups belonged to different sectors – field-staff are deployed by the public health department and the A/W, the pre-school educator and nutrition worker belonged to the Integrated Child Development Program. Field-staff fostered acceptability to vaccination through their regular house visits and constant interactions with mothers, and A/Ws increased the community's awareness of immunisation programmes. The vaccine literacy of the households was

increased not only by the constant interactions of these two workers with the households, but also because of their status in the community as a trusted source of health information.

Within a household, the mothers played a significant role in vaccination decisions as she held most of the vaccination-related information. The media contributed by carrying positive messages about immunization to community households. In the CLD depicting the reinforcing loop displayed in Figure 2 we also observed that the prevention of diseases through vaccines reinforced the household's acceptability to immunization. The widespread acceptability of vaccines is reflected by the absence of major opposition to immunization programs during this phase, as well as by a significant increase in the overall vaccination coverage (Kerala = 84%; national average = 54.2%) [18].

In a push for polio eradication, a polio vaccination campaign was introduced in 1995 as part of the Global Polio Eradication Initiative [19] by administering additional oral polio vaccine to all children under five on two national immunization days. Despite initial opposition from some medical professionals, the campaign was generally well received, benefiting from ongoing civil society participation. The opposition was from some physicians in academic settings as well as some private doctors who questioned the need for additional oral polio vaccine for a state like Kerala, when the state already had high routine immunization coverage. Initial opposition was neutralized by the public's confidence in vaccination in general and considerable state support for the program. For example, according to our respondents, there was extensive participation in the program implementation by several actors, including several government departments, in addition to health, as well as Panchayats (village level elected governance institution), NGOs, and schools. In 2000, a case of polio was reported in Kerala. Although this event was seen as a failure of the public system, the impact on the immunization program was not immediately evident and the efficacy or safety of the vaccine was not questioned.

Phase 2: Opposition

The polio case in Kerala was followed by a series of critical events related to immunization-created feedback

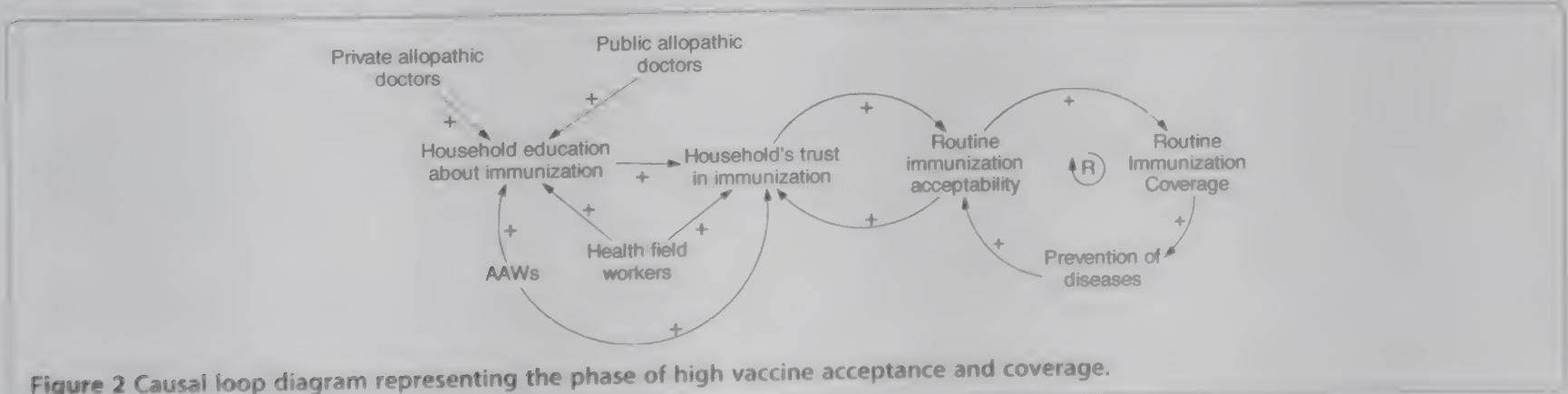


Figure 2 Causal loop diagram representing the phase of high vaccine acceptance and coverage.

loops that influenced sudden changes to the social acceptability of vaccines. Figure 3 displays the CLD that shows increased complexity and the new feedback loops that emerged. In this phase, which illustrates a number of events from 1995 to the present, we note many more actors and unexpected consequences – some arising with a delay – as well as the emergence of opposition to immunization.

Though opposition to the polio campaign emerged right at the start of the programme, these discussions mostly remained within academic circles. In 1999, the federal government decided to strengthen the polio eradication drive and introduced Intensified Pulse Polio Immunisation (IPPI). This included additional polio vaccination days and initiated mop-up rounds, which mandated the field workers and volunteers to reach out to unvaccinated children in their households and vaccinate them. The implementation of the programme was closely monitored by the public health authorities for providing logistics support and for achieving complete coverage.

However, some groups began seeing the IPPI programme, for which the state had mobilized significant resources, as an opportunity to bring out their own grievances. In 2002, the Kerala Government Medical Doctors' Association (KGMOA) publically questioned the need for IPPI in Kerala and referred to the arguments raised by some medical professionals in the beginning of the program; they announced their non-cooperation with the program. The announcement coincided with a strike called by the

association for better service conditions and was partly used as a bargain for their negotiations. They justified their stand in a press conference as a scientific argument. Though KGMOA had later backtracked and cooperated, this incident had triggered the first open debate on any immunization program in Kerala and emboldened many other groups, such as alternate system providers and some religious leaders, to raise objections against immunization programs (refer to reinforcing loop R1).

The public protest carried out against the IPPI campaign by the alternative medicine proponents was in fact a debate on the superiority of alternative medicine. For example, homeopathy professionals, on several occasions in the past, had direct confrontation with professionals representing allopathic medicine in Kerala. One of such conflicts started as far back as the 1970s, when allopathic providers opposed the initiation of a graduate programme in homeopathy in Kerala – described as the first of its kind anywhere in world. A leader of one of the homeopathic associations which has strong membership in northern Kerala described their campaign against IPPI programme as the payback time for the humiliation they had suffered from the hands of allopath.

“We cannot accept it. They declare themselves that they are big people; but we don’t feel so. If all the three systems need to coexist, then there has to be mutual recognition. When we recognise allopathy as a medical

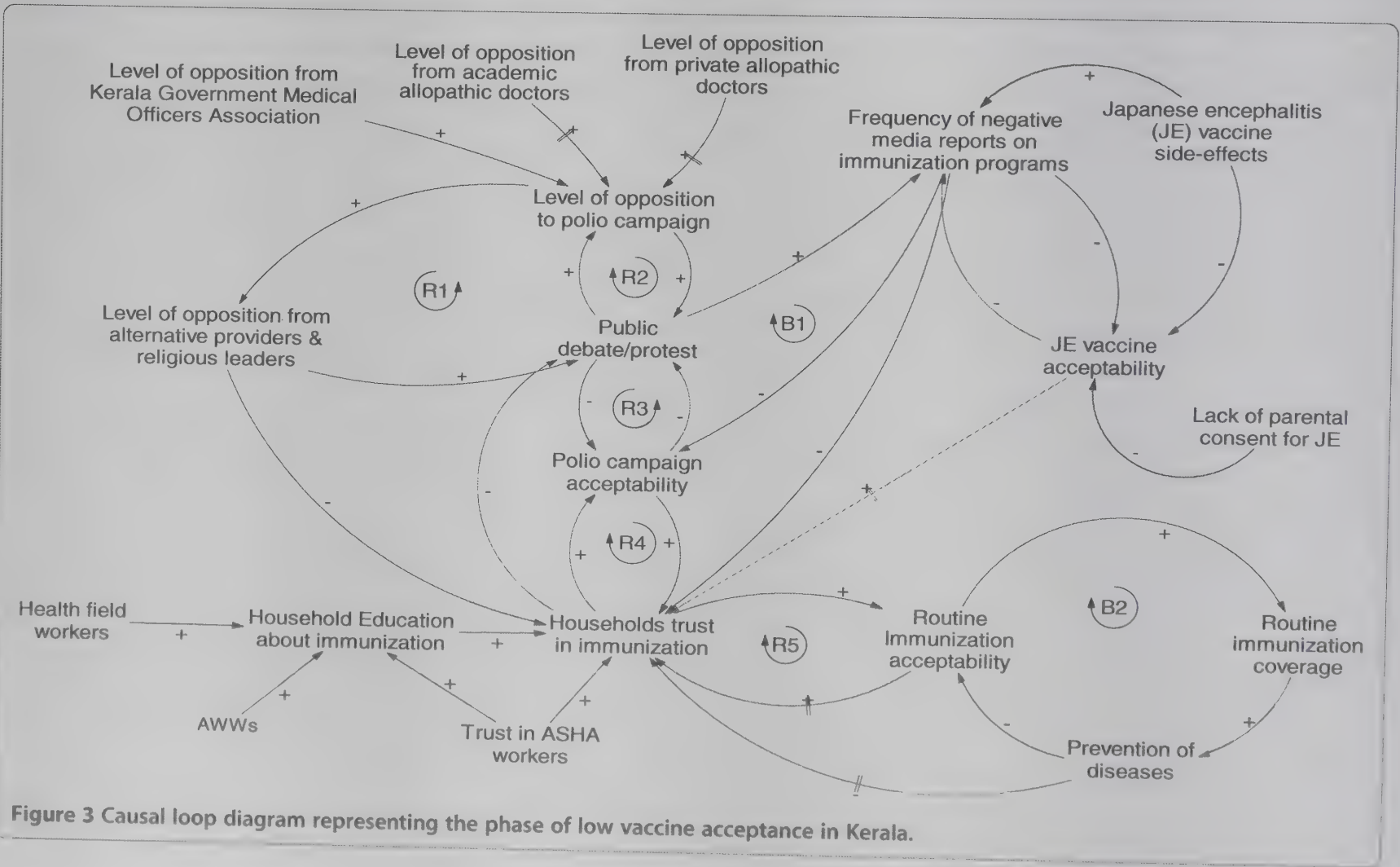


Figure 3 Causal loop diagram representing the phase of low vaccine acceptance in Kerala.

system, and if they do not reciprocate it, where is the question of dialogue? That is why we not only practice [oppose vaccinations], but we also preach to our patients against polio [vaccine].” – Homeopathic association leader Khozhikhode

The alternative medicine providers staged open protests in the north, including in the Kozhikode district. A popular health magazine of a naturopathy group had carried several articles against pulse polio immunisation, one of which was by a well-known naturopath who spoke at several public meetings against vaccines, especially the polio campaign. From 2005 onwards, opposition to IPPI from groups who opposed vaccination in general, such as homeopathy associations and experts of naturopathy, were joined by some religious organizations and was widely publicised. They often cited the opposition of IPPI by the allopathic professionals and KGMOA. This reinforced their arguments and gave credibility for their public protest (see reinforcing loop R2). Though the same groups broadcast their opposition messages across the entire state, coverage in the south was not affected by the outcry against immunization, but the northern districts began to show a decline. In the context of declining acceptability of the polio campaign, the debates that challenged the immunization programs received further credibility (refer to R3). The change in acceptability, in turn, increased public debate; especially as the negative media coverage of these events increased, thus causing a further dampening effect on vaccine acceptability (refer to balancing loop B1).

Although these frequent debates were centred on IPPI, they began to influence the community's trust in vaccines (reinforcing loop R4). Additionally, as the incidence of vaccine-preventable diseases was drastically reduced with time, the general population felt gradual loss of fear due to relative unfamiliarity of vaccine-preventable diseases in the state. This subsequently reduced routine vaccine acceptability and created a dampening effect on vaccine acceptability (see balancing loop B2). The reinforcing loop R5 denotes a potential amplifying effect of low levels of vaccine acceptability over a long period of time on a household's trust in vaccination. In the face of losing interest in immunization, the health workers found it difficult to convince the parents to vaccinate their children.

“Earlier we had cases to show to people, now they are not seeing cases; it is now like a riddle to them. We now feel that the days ahead will be even tougher” – Health worker (female), Kozhikode

In 2006, a death was reported after a school immunization program in Kozhikode district. As a result, there was an eruption of immediate public protest and violence against the local public health staff and facilities, as the safety

of vaccines were again challenged [20,21]. Immunisation programmes, and especially the field immunisations and school-based immunisation programmes, had to be stopped in most districts of northern Kerala.

Table 1 summarizes the critical events described above, and, in retrospect, their impact on the immunization system.

Though the routine immunisation programme was carried out in a similar manner, and both districts initially reached very high coverage levels, the northern district ended up with a decline in coverage for routine vaccinations. Protest against IPPI by the practitioners of alternate medicine, especially homeopathy, which is more popular in northern Kerala, was a major factor. In northern Kerala many homeopathic practitioners have actively discouraged their clients from immunising their children. Several study respondents believed that the strong influence of homeopathic medicine practitioners on households in northern Kerala helped convincing them against immunisation.

“Because they [homeopathy practitioner] have a family physician status and have good relationship with some of their clients, they oppose them from accessing the mainstream [allopathic] system. This is the limitation of the health department personnel. We are not fully able to reach to them.” – Health official (male), Kozhikode district

In northern Kerala, the popular synonym for any vaccination has always been ‘polio injection’. This pointed to the possibility that a targeted campaign against polio immunization in northern Kerala perhaps had an impact larger than its objective of opposing repeated polio drops. One of the experts interviewed reasoned that as the society did not differentiate between polio vaccines and the other vaccines, the resistance against immunization, which originally initiated against polio campaign, might have moved to routine immunization.

Even though the routine vaccination was well accepted in the southern district, a school-based program for Japanese encephalitis introduced in Alappuzha district by the public health department created wide-spread public debate on the rationale and safety of vaccines. The limited success in the Japanese encephalitis program was explained by multiple media reports on increasing the side effects of the vaccine, challenges of the health department in collaborating with resistant schools, and parents refusing to send their children to school on campaign days. Though there was no immediate impact of the events on routine immunization, experts, interviewed for this study, have suggested future potential negative feedback (represented by a dotted arrow in Figure 3) of such debates on routine vaccination.

Table 1 Major events and its influence on immunization coverage

Landmark events	Period	Characteristics of the events	Impact on immunisation
EPI	1978	State supported immunisation programme, lower coverage due to lesser vaccine acceptability and supply constraints.	Low vaccination coverage.
Introduction of UIP	1985	Strong political commitment to immunisation, extensive organisation for the delivery of immunisation service, weekly immunisation.	Improvement in vaccine acceptability. Overall coverage began to improve.
Introduction of polio eradication initiative	1995	Introduced as special event and additional vaccines in addition to routine. Polio eradication drive was well received by community. Active participation of civil society in its implementation. Doubts against oral polio vaccines raised by some from public health community.	Improved coverage for routine immunisation. Successful implementation of polio eradication drive.
Last case of polio reported in Kerala	2000	Widely reported in Kerala. This was seen as a failure of public health system.	No specific impact on immunisation programme.
Opposition of IPPI immunisation strategy by KGMOA	2002	The opposition coincided with the strike call by the association. The issues were widely discussed in the media. The association backtracked after the strike was resolved.	No immediate impact on vaccination coverage, however, first open debate in Kerala on any immunisation programme.
Organised opposition against from IPPI by various groups	2005 onwards	Opposition was mainly from homeopathy groups and some experts of naturopathy, also supported by some religious organisations. Motive of continuing IPPI was openly discussed from both a technical and conspiracy angle.	Immunisation coverage in northern districts showed a decline. Coverage is intact in southern districts. Increased reporting of VPD cases in northern Kerala.
Death reported after school vaccination programme in a northern district	2006	Eruption of immediate public protest and violence against the local public health staff and facilities. Widespread anguish felt among public as the safety of vaccines were challenged.	Reported to have had an impact on vaccination coverage in northern districts.
Special school based Japanese encephalitis vaccination programme in Kerala	2008	Wider public debate, on the rationality and safety of vaccination programme. Media reports of vaccine side-effects impacted the programme. At the implementation level, difficulties in organising events in collaboration with schools.	Limited success in Japanese encephalitis vaccination programme.

EPI, Expanded Programme for Immunisation; IPPI, Intensified Pulse Polio Immunisation; KGMOA, Kerala Government Medical Doctors' Association; UIP, Universal Immunization Programme; VPD, Vaccine Preventable Disease.

Official response to decreasing immunization coverage

An immediate state public health department’s response to the decline in the public image of immunization in northern Kerala has been to strengthen the programme which included assigning high immunization coverage targets to staff at all levels and a close scrutiny of their achievements. It was observed, for example, that during the regional review meetings, if the coverage of a particular vaccine was less than expected, a close scrutiny and justification was sought from the fieldworker and the supervisor.

Over-emphasis on coverage targets created perverse incentives for health providers to inflate their coverage estimates, and has made the immunization coverage data generated by the health department grossly unreliable as evident from several independent surveys which reported significantly lower levels of coverage. Besides, it often resulted in coercion of resistant households for vaccination. During the mop rounds for polio eradication campaign, heated exchanges between health field workers and members of households that are resistant to immunize their children were observed in many places; “...may be because when it is forced, they may think it is for the others benefit not for their benefit” –

commented one of the experts who is also a district level immunization program manager.

Another strategy used in responding to the crisis was to confront with the groups that opposed immunization. For example, the public health administration, which is dominated by allopathic system of medicine, retaliated against homeopathic professionals by issuing a government order to set-up vaccine booths in government-owned homeopathy dispensaries. They described this as a strategic move and prominently projected it in a press conference and in the press statements issued on the previous day of the campaign. The homeopathy practitioners’ association found this step as intimidating and one of their office-bearers who was interviewed communicated the association’s resolve to oppose the program more strongly.

The official response also included the use of community intermediaries to counter the misinformation against immunization. However, many of the field staff in Kerala had accepted that their ability to influence families in health-related decisions have reduced over the years, especially with the decline in the frequency of house visits. The introduction of community health workers known as Accredited Social Health Activists (ASHAs) has, therefore,

played a positive influence in decision making of the parents on immunization. ASHA's status as local women known to the other members of the community gave her special advantage in influencing the perceptions of community on immunization issues. During her house visits information is shared as part of a day-to-day communications. The messages related to health and immunization gets discussed and exchanged during such interactions. In addition, in their role as teacher of pre-school children, AWWs also had special access to mothers when they come to drop or pick up their children from the pre-school and used the opportunity to influence mothers' behaviour towards immunizing their children. One of the experts interviewed had noted that the health department overlooked the potential of AWWs which resulted in gradual decline of the role of AWWs in immunization. The future potential of the right kind of interactions of AWWs and ASHAs with the households to create reinforcing loops to improve trust in vaccination is denoted by dotted arrows and loops in the Figure 3. Likewise, we also anticipate a change in disease situation due to reduction in vaccine coverage which may increase vaccine acceptability in future and improve household's trust in vaccines.

Nevertheless, an important limitation of the strategy to use community level workers, such as ASHAs, to improve household acceptability of immunization was often observed during home visits. The mothers whose children were not vaccinated said that the decision not to vaccinate was taken by the male members of their households. *"When we speak to mothers many of them will point fingers at husband, father-in-law, or mother-in-law."* – commented one of the paediatricians interviewed when asked about her ability to convince families who refuse vaccination. There was a greater likelihood that the male members got influenced by external factors, such as the media and the public protests, used by the alternative medicines groups. Given that the mobilization strategies used by the public health system, including ASHAs, were often designed to target mothers in the households and community, the impact of these strategies was not as intended given the important role of the male members.

Discussion

Using a CAS lens facilitated the identification and understanding of unintended consequences and unexpected phenomena. Our CLDs illustrated the complexity underlying immunization coverage in the northern districts of Kerala and showed that the campaigns and the messages targeting against special immunization programs by some of the interest groups had consequences larger than intended as it affected households' acceptability of routine immunization. The events that occurred at different points in time had a delayed and cumulative impact on

vaccine acceptability. Our findings also showed that several informal day-to-day societal interactions within the households and community played crucial roles in creating and changing vaccine acceptability. For example, the decision making for immunization during the phase of vaccine resistance in northern Kerala showed a prominent role of male members of the households in contrast to the role played by mothers during the acceptability phase.

A crucial question proposed is regarding how the public health departments governing immunization programs can retain or regain vaccine acceptability in complex contexts such as in Kerala. Our CLDs shows that several events, related or unrelated to immunization programs, affected vaccine acceptability through new actors and their interactions (Figure 3). These new interactions influenced the pathways of feedback that created vaccine acceptability in the beginning (Figure 2). The comparison of two regions in Kerala showed greater impact of feedback from actors, such as practitioners of alternate systems of medicine, negatively affecting vaccine acceptability in northern Kerala as they have stronger influence over households. Therefore, understanding what factors influenced the direction of the feedback and modulated its potential to impact the vaccine acceptability pathway assumes importance.

The study findings, as well as our review of the literature, shows 'trust' as an important factor that modulates this feedback between actors [22,23]. For example, our findings reveal that from a period of suspicion and rejection, vaccines have achieved public confidence mainly through a positive feedback mechanism facilitated by its capacity to demonstrate reduction of diseases in the community (Figure 2). Information against immunization programs and the occasional reporting of vaccine-related adverse events undermined a household's trust in immunizations. In the context of a low burden of vaccine-preventable diseases (due to several years of good vaccination coverage), the reductions in trust created a negative feedback loop that dramatically affected vaccination acceptability and coverage. We discuss our findings in the light of two theoretical interpretations of trust; trust in expert systems, and interpersonal trust, to understand the feedbacks and to explore strategies for the better governance of immunization services [22].

In the first view, acceptability to immunization in the initial phase in Kerala can be viewed as a result of the trust in institutions of professional expertise (in this case, medical knowledge) [24]. However, the conflicting messages that emerge from different systems of medicine challenge the trust which people attribute to expert systems of vaccination. The studies on vaccine resistance in other contexts, too, have noted sudden loss of trust in vaccines when counter campaigns question the scientific basis of vaccinations [25,26]. Consistent health messages,

especially from different sources of expertise, is important and can be achieved by engaging in dialogue that generates consensus rather than direct confrontation with other systems of medicine, as attempted by the public health department in Kerala. We also see a possibility of immunization programs regaining household trust when vaccine-preventable diseases reappear with the decreasing coverage (denoted by a dotted arrow with delay mark in Figure 3).

The role that the media played in such contexts in informing households with conflicting messages on immunization and how the key actors trusted each information requires attention. As observed by Giddons, plurality of information, a feature of late modernity, is a reality of many societies in the developing world and has implications on governing public health functions like immunization services [27]. For example, in Kerala, where increased penetration of 24 hours local electronic news media and several widely-read health publications, are informing households on every immunization-related side-effect and public debate on immunization programs. Sensitizing the media for more responsible reporting and using it to convey appropriate health messages are options that public health departments may use in such situations, even though it is unlikely to eliminate all unwanted information from reaching households.

In the second interpretation, trust is approached as a cognitive phenomenon or a judgment based on a rational gamble and therefore household perception of other actors' interests is important. One of the strategies of the public health department to influence the household level decision making using community level functionaries like ASHAs, therefore, has a potential (denoted by a dotted arrow in the Figure 3). Because of the social networks in which ASHAs are interconnected, households can perceive them to serve their interests. Previous studies from other health system settings also conform this finding [28]. A study of treatment-seeking behaviour in urban Sri Lanka noted the perception of community on the motives of healthcare workers as a central factor to the formation of trust in health services, especially in the face of uncertainty about health conditions [29].

Trust in health workers can also be explained through the notions of 'affective trust', which is developed through emotional bonds and obligation generated through their repeated personal interactions with the households [28]. However, we observe that the trust created by community level health functionaries is intrinsically related to how they interacted with the households. In the backdrop of widespread misinformation against immunization in Kerala, when the functionaries are forced to deliver against rigid performance targets, it leads to coercive practices and may undermine the health worker's long-term trust with the community. Thiede's analysis of origin of trust

and mistrust in healthcare draws a similar conclusion that, while trust enhanced communication of health workers, it was the process of communicative interaction that generated trust in the first place [23].

In the bureaucratic context of implementation of UIP, there was limited recognition of the need to influence informal interactions that retains trust in vaccines and in the public health department that governs immunization programs. The governance of immunization was seen as an exercise to ensure control and order through top-down hierarchical interactions. At each level, the program is conceived as an array of demands to be met. This absolves the capacity of the system to adapt to emerging complexity. Similar observations on public health bureaucracy have been made by other studies that looked at target-driven top-down implementation of public health programs in the South-East Asian context [30-32].

This study has various strengths and limitations. Using a CAS framework to guide data analysis and interpretation contributed to understanding the complexity involved in the governance of immunization services in a developing country context. It showed how system thinking concepts and methods can be applied to a complex question such as changing household acceptability to immunization. We also showed how tools such as CLDs can be used to explore social phenomena interlinked to governance of public health functions and interpret feedback loops that influenced the change in vaccination coverage. Development of CLDs based on content analysis of qualitative data and using these CLDs to guide further thinking of the complex system behaviour is arguably a unique feature of this analysis.

There are, however, several limitations to this study. Firstly, it included only two districts in the analysis of the reasons for the change in vaccination coverage in Kerala and it may not necessarily apply to other settings. Though the resistance against immunization is widespread in Kozhikode district, the intensity of resistance is varied in different regions of the district. Our description of resistance phenomenon is only pertaining to the areas that showed significant levels of resistance and cannot be applied to regions with good vaccination acceptance. This study tries to interpret and propose corrective strategies only on the basis of an ex-post analysis of complexity and therefore does not reflect on the experience of a health system that regained vaccine acceptability after losing it. For example, the study did not reflect on the changes in vaccination coverage in Alappuzha district that had occurred in the earlier phase. The CLDs could not be validated, and therefore may reflect inaccurate linkages. Additionally, it is possible that the authors omitted potentially important variables and events.

Conclusions

We argue, through this article, that the evidence base of public health programs, such as immunizations, should go beyond epidemiological and economic analysis. Our study emphasizes the need for public health governance systems to take into consideration the nature of multiple interactions when societies organize themselves to manage a public function like immunization. This perspective goes beyond the conventional assumption that the government’s public health department is the sole governor of public health issues divorced from wider societal forces such as other key providers, social networks, and the households themselves with which the decision to vaccinate lie. It should make a careful consideration of multiple interactions involving the actors and their perceptions and ideas, which are shaped by factors such as trust.

The traditional approach to public health governance is directed by hierarchical organization designed to direct, control, and/or to even prevent interactions. However, complexity ensures that interactions will lead to unpredictable changes. The effort of the public health department should be to influence the multiple interactions of various governance actors and institutions.

Abbreviations

AWW: Anganwadi workers; ASHA: Accredited Social Health Activist; CAS: Complex Adaptive System; CLDs: Causal loop diagrams; IPPi: Intensified Pulse Polio Immunisation; KGMOA: Kerala Government Medical Doctors’ Association; UIP: Universal Immunization Programme.

Competing interests

The authors declare that they have no competing interests.

Authors’ contributions

JV and VRK contributed to the design, implementation, analysis, and interpretation of data and LP and TA contributed to the analysis and interpretation of data. All authors were involved in drafting and revising the manuscript. All authors read and approved the final manuscript.

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Advancing the application of systems thinking in health: provider payment and service supply behaviour and incentives in the Ghana National Health Insurance Scheme – a systems approach

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Abstract

Background: Assuring equitable universal access to essential health services without exposure to undue financial hardship requires adequate resource mobilization, efficient use of resources, and attention to quality and responsiveness of services. The way providers are paid is a critical part of this process because it can create incentives and patterns of behaviour related to supply. The objective of this work was to describe provider behaviour related to supply of health services to insured clients in Ghana and the influence of provider payment methods on incentives and behaviour.

Methods: A mixed methods study involving grey and published literature reviews, as well as health management information system and primary data collection and analysis was used. Primary data collection involved in-depth interviews, observations of time spent obtaining service, prescription analysis, and exit interviews with clients. Qualitative data was analysed manually to draw out themes, commonalities, and contrasts. Quantitative data was analysed in Excel and Stata. Causal loop and cause tree diagrams were used to develop a qualitative explanatory model of provider supply incentives and behaviour related to payment method in context.

Results: There are multiple provider payment methods in the Ghanaian health system. National Health Insurance provider payment methods are the most recent additions. At the time of the study, the methods used nationwide were the Ghana Diagnostic Related Groupings payment for services and an itemized and standardized fee schedule for medicines. The influence of provider payment method on supply behaviour was sometimes intuitive and sometimes counter intuitive. It appeared to be related to context and the interaction of the methods with context and each other rather than linearly to any given method.

Conclusions: As countries work towards Universal Health Coverage, there is a need to holistically design, implement, and manage provider payment methods reforms from systems rather than linear perspectives, since the latter fail to recognize the effects of context and the between-methods and context interactions in producing net effects.

Keywords: Complex adaptive systems, Ghana, Incentives, Provider payment, Supply, Universal health coverage

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Introduction

In 2005, the member states of the World Health Organization committed to Universal Health Coverage (UHC) [1]. Specifically, their commitment was to develop their health financing systems so that their citizens would have universal access to essential health services (defined in context) without having to suffer financial hardship in paying for them. Subsequently, in 2012, the United Nations General Assembly, in resolution A/67/L.36 of its 67th session [2], called upon member states “to value the contribution of Universal Health Coverage to achieving all inter related Millennium Development Goals with the ultimate outcome of health improvements...”. For the purposes of this paper, we use UHC in our understanding of the essence of the World Health Organization definition of ensuring equitable universal access to a core package of essential health services without exposing people to undue financial hardship [3]. The details of this ideal will have to be defined in context; in all contexts it requires adequate resource mobilization as well as the equitable and efficient use of available resources. A critical part of this effort will be provider payment methods [4].

Provider payment methods refer to the mechanisms used to transfer funds from the purchaser to the providers of health services. These methods include line item and global budgets, salaries, capitation with or without fund holding for referral services, case-based payments, and fee for service with or without a fee schedule. The provider payment system, on the other hand, refers to the payment method combined with all supporting systems such as accountability mechanisms, management information systems, etc. Different provider payment methods create different provider behavioural incentives related to service supply since they have different effects on the relationship between provider income and costs for providing the service, as well as the relationship between activities and payment [4,5]. Apart from financial incentives, provider supply behaviour can be influenced by other factors, such as peer, professional, and client pressure, and factors internal to the provider such as value systems and ethics.

Also important to understanding incentives is that provider payment methods are introduced and implemented in health systems. Systems are made of separate but interdependent parts that interact with each other. Occurrences and outcomes within systems can only be fully understood by appreciating the relationship and interconnectedness between these parts [6-8]. Moreover, health systems are complex adaptive systems (CAS), constantly changing and governed by feedback. Intervening in one part of the system will almost always have ripple effects in other parts; they self-organize and adapt based on experience. To fully understand incentives in a CAS, it is important to apply a systems thinking perspective,

studying the context in which the payment method has been introduced and the resulting interactions.

The current study therefore set out to explore, from a systems thinking perspective, the questions of: “What kinds of provider behaviour are occurring related to supply of health services to insured clients in Ghana?; What incentives might be driving the behaviour?; and What is the influence of provider payment methods on the incentives and the behaviour?” Our focus was on financial incentives for service supply behaviour related to the nationwide National Health Insurance (NHIS) provider payment methods of the Ghana Diagnostic Related Groupings (G-DRG) for services and itemized fees with a fee schedule for medicines. A per capita payment for primary care, which was an early pilot in one region at the time of the investigation, was not included in our research given the focus on nationwide payment methods. The focus on financial incentives was selected since behaviour motivated by financial incentives (real or perceived) was and remains a source of much debate, conflict, and concern within the Ghana NHIS and links closely with concerns about cost escalation and cost containment.

Context: economic, socio-demographic, and health

After a long period of near stagnation, Ghana has seen rapid growth in its GNI from an estimated US\$ 320 per capita in 2003, when the NHIS law was passed, to US\$ 1,410 (Atlas method current US\$) in 2011 [9]. It is traditionally an agricultural country with cocoa, timber, and gold as its main exports. Oil was discovered off-shore in 2006 and production in commercial quantities started in 2011. The amounts produced are still small, but the importance of oil to its economy is growing, and it has played some role in the evolution of its GNI per capita. The Consumer Price Index, which measures the percentage change over time in the general price level of goods and services in a country, has risen each year and has remained high over several decades. Annual averages since 2003, when the NHIS was established, have ranged between 10% to 27% [10,11] and the value of the cedi has declined against the dollar.

About half of Ghana's estimated population of 26 million are below 15 years old. The majority of formal sector workers, with some exceptions, such as employees of some tertiary educational institutions, belong to the Social Security and National Insurance Trust (SSNIT) pension scheme. Based on the 2011 SSNIT annual report, 963,619 Ghanaians (about 4% of the total population) were active contributors [12]. Even if the figures are doubled to include formal sector workers who do not contribute to the SSNIT pension scheme, it would be reasonable to estimate that about 80% of Ghana's adult working population is employed in the non-formal sector.

Mortality of children under 5 years has declined, albeit very slowly, from 155 per 1,000 live births in 1983 to 1987, to 80 per 1,000 live births in 2003 to 2008 [13]. Maternal mortality declined from 503/100,000 in 2005 to 451/100,000 in 2008 [14]. Shortages of skilled human resources have been and remain a problem. The World Health Report 2006 estimated that Ghana had 0.15 physicians and 0.92 nurses per 1,000 population. This compared with 2.14 and 9.95 in a high-income country like Canada and 0.77 and 4.08 in a sub-Saharan Africa middle-income economy like South Africa [15]. The country's challenges, with inadequacies in infrastructure, equipment, tools, and supplies in the health sector, mirrors its human resource challenges. A little under 15% of the public sector budget is allocated to health and the per capita expenditure on health in 2013 was estimated at US\$35 [16].

The Ghana Health Service, the service delivery agency of the Ministry of Health, employs most public sector providers. Others are employed by other public sector agencies with hospitals of their own, e.g., the Military, Police, and the Universities. Private service delivery is done by not-for-profit and self-financing (for-profit) providers. Mission clinics and hospitals under the umbrella of the Christian Health Association of Ghana (CHAG) form most private not-for-profit providers. The private self-financing sector is made of individual physician, dentist, and midwife practices, hospitals, laboratories, and pharmacies.

The Ghana National Health Insurance Scheme (NHIS)

In September 2003, Ghana passed a national health insurance (NHI) law (Act 650) to replace public sector user fees introduced in the 1980s as part of structural adjustment programs. Though the term UHC was not used, the government's stated policy objectives in setting up a NHI scheme show the principles of UHC. Both the original [17] and revised [18] NHI policy frameworks state: *"...the vision of government in instituting a health insurance scheme... is to assure equitable and universal access for all residents of Ghana to an acceptable quality package of essential healthcare... every resident of Ghana shall belong to a health insurance scheme that adequately covers him or her against the need to pay out of pocket at the point of service use in order to obtain access..."*.

The Ghana NHIS is described in several publications [19-22]. The benefit package covers about 80% to 90% of the most common clinical conditions in Ghana. The NHI has a single payer arrangement through the NHI fund. The NHI fund is about 70% to 75% from a value added tax and 20% to 25% from formal sector SSNIT contributions, 2.5% of which are mandated to be transferred into the NHI fund monthly. A small amount of NHI financing comes from the annual premium, non-

SSNIT contributors pay out of pocket and the registration fee paid by all subscribers.

Nationwide NHIS provider payment methods

Ghana's NHIS started implementation in 2004, with itemized billing with no standardized fee schedule for services and medicines as the provider payment method for public and private service providers. Each of the district schemes negotiated with their providers itemized fee rates for services, consumables, and medicines. In the face of growing concerns over inefficiencies such as random price variations for the same procedures and consumables, cumbersome billing and claim vetting procedures and cost escalation, the National Health Insurance Authority (NHIA) introduced, in 2008, a case based payment system known as the G-DRG for services and procedures, as well as standardized itemized fees for medicines based on a medicine list. Apart from a few modifications, this payment system has remained in use across Ghana in its original design since then.

Classically, the two core components of a DRG payment system are a patient classification system and a payment rate setting mechanism that takes into account the intensity of resources used to treat patients in a given DRG category to give cost weights or prices to the DRG [23]. The G-DRG is not a pure DRG system in that, although it has the patient classification system, it does not have cost weights and severity levels. It was designed, applied, and continues to be applied nationwide for all levels of care from the lowest (Community Health Planning and Services (CHPS) compounds) to the highest (teaching hospitals), to pay all accredited providers – public, quasi-government, and private – for inpatient and outpatient services. The tariffs reflect preceding charges rather than a precise or economic costing; capital and equipment costs are not included. The tariffs are classified into three broad groups of diagnoses, procedures/operations, and investigations. The calculated direct cost of the services for consumables and labour are uniform for related or similar diagnosis, procedures, and investigations irrespective of level of care.

Indirect or overhead costs comprising labour, vehicle maintenance and fuel, equipment and building maintenance, housekeeping, utilities, and general administrative and office expenses are calculated, increasing from the lower to the higher level of care. The rationale is that facilities at higher levels of care consume larger amounts of overhead inputs because of their size and higher fragmentation of services. The tariffs vary according to whether the facility is government, mission, or private to take into account the government subsidy, mainly for salaries but also some infrastructure, equipment, and overhead costs in the public and, to some extent, the private mission sector, as well as the zero subsidy in the private self-financing

sector. The tariffs also vary by type of final service (inpatient or outpatient), type of intermediate service (laboratory investigations, imaging investigations, theatre, catering services), and specialty (obstetrics and gynaecology, medicine, surgery, child health, eye, ENT, and dental). Since some district hospitals have catering services and others do not, inpatient tariffs differ by district hospitals with catering services and those without [24].

The itemized fee schedule for medicines is based on a NHI medicines list (NHIML) that is periodically revised. Medicines can be dispensed by public and private provider facilities with an in house pharmacy/dispensary or by private community practice pharmacies accredited by the NHIA. Most community practice pharmacies, like other private self-financing services, are based in wealthier and peri-urban areas. Poorer rural communities rely on chemical sellers (lay people licenced by the Pharmacy Council to sell over the counter medicines). Some of these are also accredited by the NHIA. In theory, there is supposed to be a separation between prescribing and dispensing; in practice, it is not enforced.

Payment to providers for services and medicines was and remains retrospective. Providers file claims, which go through a vetting process in the NHIA district scheme offices or for the higher-level facilities such as teaching and regional hospitals in the computerized central claims processing office of the NHIA, before final payment. The claims processes of many provider and district scheme offices remain predominantly manual despite increasing computerization. There remain administrative capacity, human resource, technical, and other challenges that slow down the process and can reduce the final value of the reimbursements [25].

The first review of the G-DRG tariffs after introduction in 2008 occurred when the Minister for Health, in response to provider agitations, announced an interim upward adjustment of G-DRG tariffs effective 1 July 2011. The increments were calculated based on an analysis of the trends in medical inflation since 2008, when the G-DRG was first introduced. Inpatient tariffs were increased by 30%, primary outpatient care by 22%, diagnostic services by 22%, and secondary and tertiary outpatient care by 25%. In that same year (2011), the first formal review of the G-DRG was commissioned by the NHIA. Stallion & Milliman Consultants were engaged for this review whose objectives were to: "*simplify the fee system, increase transparency and ensure that the G-DRG developed were consistent with Ghana's standards of treatment*" [26]. The review was completed in 2012 and resulted in a further upward adjustment in the rates for all the G-DRG and some changes in the G-DRG groupings with some removed or merged, or new ones developed. The overall average change in the G-DRG tariffs was about 26% above the rates that were set in

July 2011. Implementation of the new tariffs started on 1st February 2013.

The first review of the NHIML and prices was in October 2009, the second in March 2011, and the third in July 2013. Data on the percentage increase in tariffs for the first and second review could not be found. However, for July 2013, the rise in tariffs was about 12% above the preceding levels.

Many inputs into health service delivery in Ghana are imported. Figure 1 shows the total value of NHIS reimbursements for medicines and services to providers over time. In cedi terms, the amounts have risen steeply, in dollar terms (exchange rates at 4.00 pm UT on 30th June each year) the rise is slower and flattening.

Other provider payment methods

The health system had other provider payment methods with which the G-DRG for services and itemized fee schedule for medicines came to co-exist. The Government of Ghana line item, global budgets, and salary payments provide supply side subsidies to public providers from consolidated tax funds for service delivery, administration, infrastructure, equipment, tools, and supplies. Some supply side subsidies to public sector providers also come from donor Sector Budget Support and program funding. Allocation of Government of Ghana funds to public sector facilities is often based on historical budgets despite the theory that with the Medium Term Expenditure Framework reform these budgets would be tied to Ministry, Department, and Agency vision, mission, objectives, and plans of action for the year. A major reason for this would appear to be that the national budget is so constrained it makes it difficult to relate allocations to requests. Fund flows also tend to be irregular and unpredictable in amount. CHAG facilities also receive supply side subsidies since a large proportion of staff salaries are paid from Government of Ghana Consolidated Funds. Most CHAG facilities are located in underserved areas, considered as priority for service delivery, and are seen as supporting government to attain its equity and access goals in service delivery.

Private self-financing (for-profit) providers receive no government supply side subsidies. They rely for their income on activity-based payments related to services and population, namely out of pocket payments by clients, direct reimbursements by some corporations, and, since 2004, NHIS reimbursements. Sometimes these providers chose not to participate in the NHIS because they consider the tariffs inadequate. Before the introduction of the NHI scheme clients in public and private sectors paid out of pocket fees based on itemized fees with no fee schedule. Non-insured clients continue to pay these fees in both sectors. Some public sector providers earn extra income through part time locums in private facilities. In some

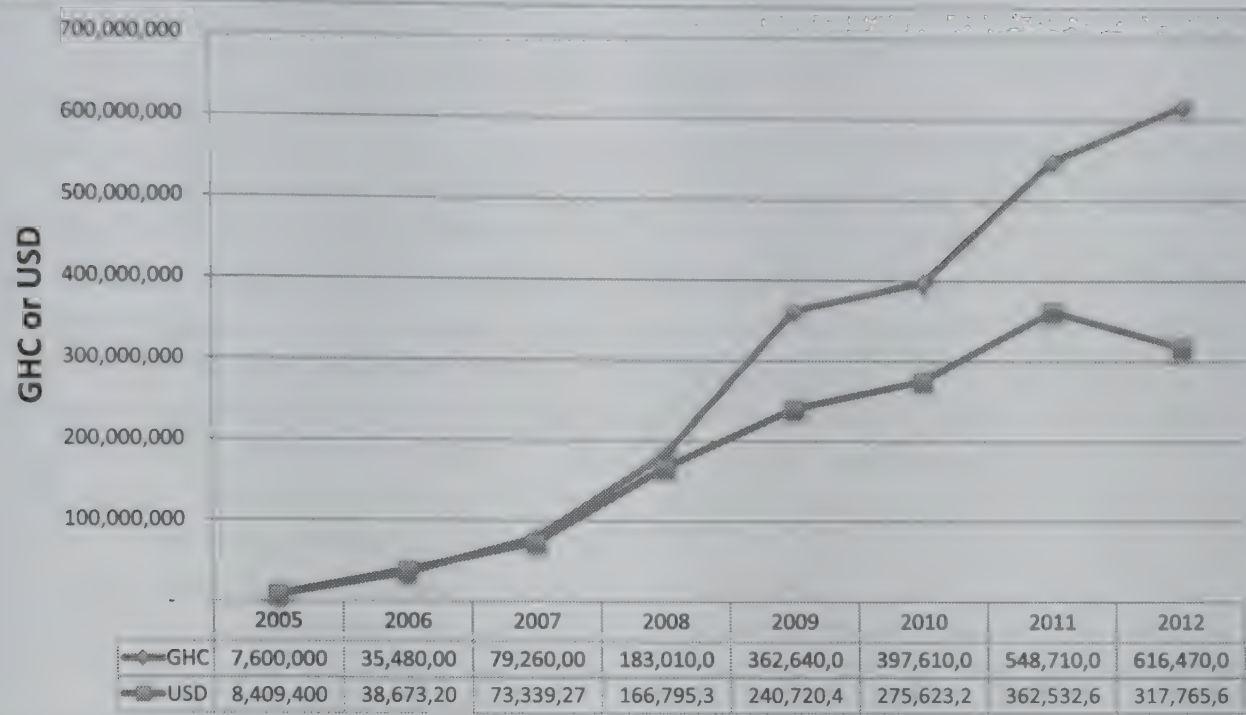


Figure 1 Total value of all NHIS claims (medicines, services, inpatient, and outpatient) reimbursed.

instances they may actually own a private practice. Reports of under the table charges by some public sector providers also exist but it is hard to document the extent of the practice.

Implementation of a pilot per capita payment method for primary outpatient care has been on-going in the

Ashanti region of Ghana, which has 19% of the population, since January 2012. Plans to scale up per capita payment for primary care nationwide have been announced. Figure 2 summarizes the purchasers and providers in the Ghana health system, method(s) used by each purchaser, and fund flow from purchaser to provider.

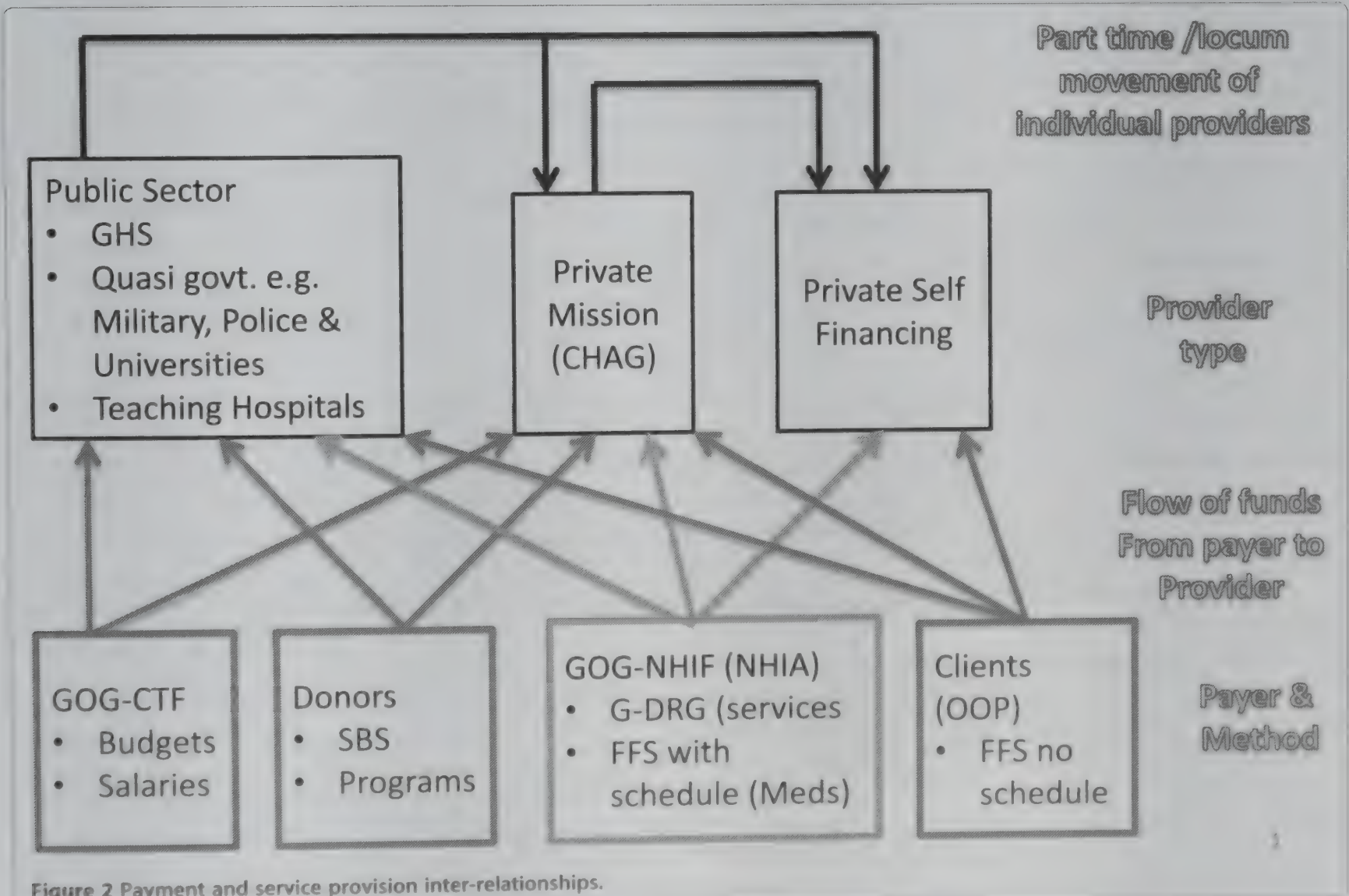


Figure 2 Payment and service provision inter-relationships.

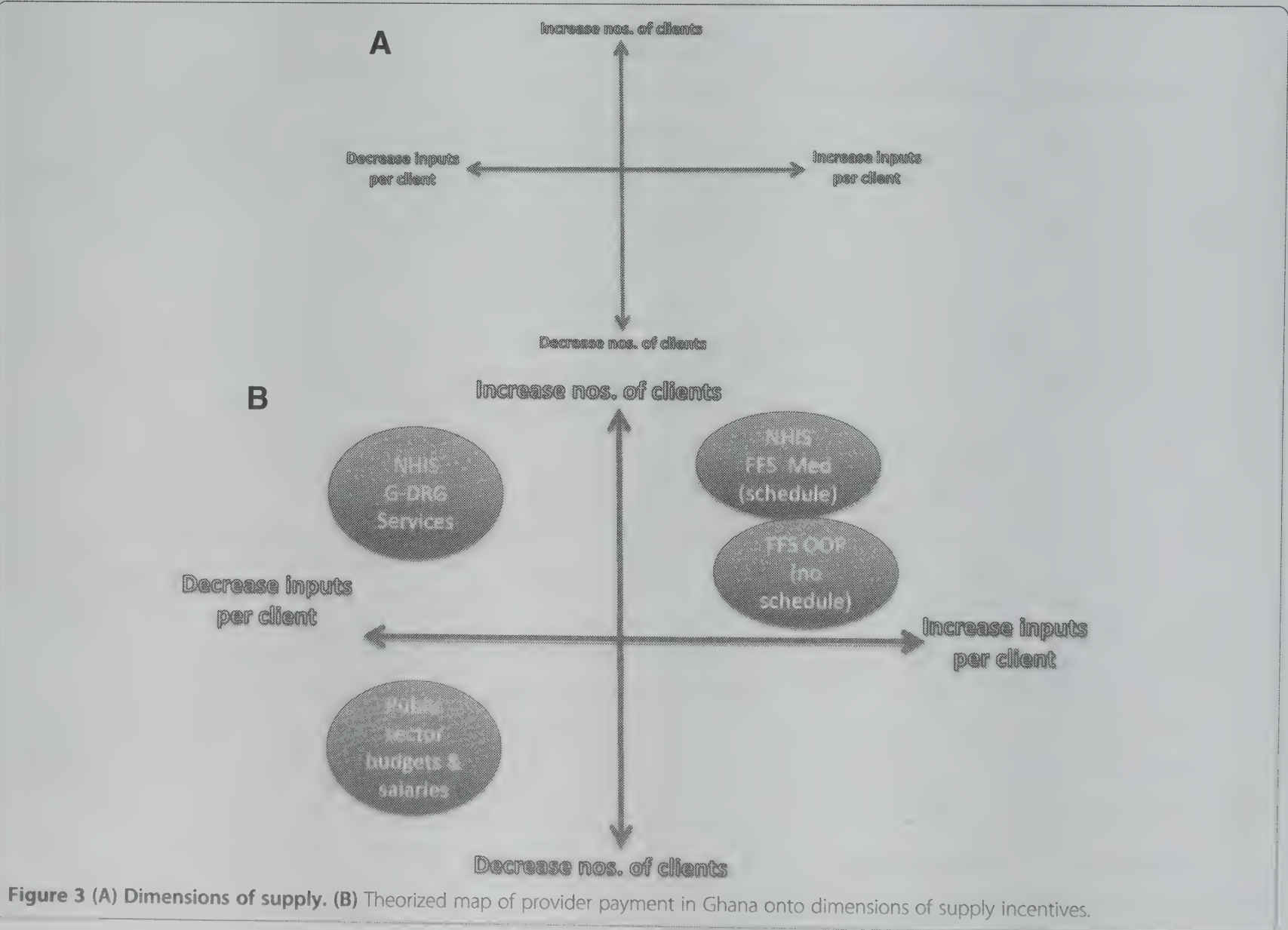
Theoretical framework

There are several theories of provider behaviour that predict incentives and supply responses to payment methods. Building on literature reviews [4,5] of provider payment methods and the financial incentives for supply behaviour they potentially generate we theorized that supply can be modified in two broad dimensions. One dimension is related to the numbers of client encounters a provider has in a given time period. This dimension can change by an increase or decrease in the individual numbers of clients making up the provider's client pool, or in numbers of visits per client for the same pool, or a combination of the two. Question in relation to this dimension would be whether there are incentives for providers to try to increase or reduce numbers of encounters. A variety of means, such as modifying opening and closing hours, referring or not referring clients to other providers, making the service more or less attractive to clients, etc., could be employed by providers to affect this dimension. Incentives to have more client encounters would not be infinite but bounded by the provider infrastructure, equipment, tools, supplies, and human resources, as well as the perceived and actual

value of the alternative uses of provider's time and resources.

The second dimension of supply would be related to the inputs into the services provided in each client encounter regardless of the number of encounters. The manifestation of this dimension would be related to incentives to supply more or less medicines, laboratory tests, procedures, etc. Again, the incentive to supply more or less would be bounded rather than infinite. These two dimensions could be simply summarized in the form of a graph as in Figure 3A. The theorized expected incentives in these two dimensions for each of the provider payment methods operational in Ghana, based on the review of the literature, without analysing the effect of context and interactions with other provider payment methods in the system, can be mapped onto this graph as in Figure 3B.

Since our objective was to understand service supply behaviour and incentives related to the NHIS provider payment methods in the context of Ghana and its health system, we went beyond the simple linear theoretical model of Figure 3A,B and drew on realistic evaluation [27] and systems thinking theories including the concept



of the health system as a CAS [6] for our analysis. We have already described features of CAS and the relevance to this study in our introduction.

Realistic evaluation theory suggests that a particular action(s) leads to outcome(s) or effect(s) by triggering a mechanism or set of mechanisms acting in context. The link between action and outcome is thus complex and non-linear. Thus, the observed effects of provider payment methods in the Ghanaian health system may not manifest as direct linear causative effects between the payment method and the observed service supply behaviour as theorized in Figure 3B. Rather, any given provider payment method will interact with the context and other methods to trigger mechanisms that would lead to observed service supply behaviours and incentives. They could, but would not necessarily be, as predicted from the theoretical linear analysis in Figure 3B.

Methods

The study was carried out over a 6-month period from March to August 2013 using mixed methods of data collection. Google and PubMed searches for “provider payment methods in Ghana”, “provider payment systems in Ghana”, “Ghana DRG payment system”, and “Ghana National Health Insurance Scheme” were used to identify grey and published literature for review. The Ministry of Health, Ghana Health Service, and NHIA websites were searched for reports with relevant information. Additionally, key informants were asked whether there were any reports, administrative memo, and other material in their records and archives related to provider payment methods that could be made available for review. The search was focused on the period January 2003 to August 2013. Routine management information system data of providers and schemes related to utilization and claims over the same period was obtained for secondary analysis. Some of the national level provider data could not be obtained for the period 2005 to 2007.

Primary data collection at the regional and district level was conducted between April and June 2013. Follow-on interviews and two validation meetings with respondents to discuss our initial analysis and conclusions were conducted in July/August 2013. Table 1 summarizes the geographic location of primary data collection, methods of data collection, and number of respondents for each method employed. The study had several questions beyond the ones presented in this paper. We only describe variables and indicators from which data was drawn to answer the questions of this paper.

The national level key informant interview guide items explored how the G-DRG and itemized fee schedule for medicines payment methods were designed and implemented, and perceptions of service supply incentives and behaviour related to the design and implementation.

At the district level, key informant interviews were held with District Insurance Scheme office managers, District Health Directorate staff, and health facility managers. Areas covered in the interviews were observations and perceptions of how the NHIS provider payment system had affected health facility and insurance scheme office decisions related to service supply and the advantages and disadvantages of the methods.

Within health facilities, observations of time spent by clients at different service points and in total, prescription content analysis, and client exit interviews were carried out using observation checklists, interview guides, and semi-structured questionnaires. The client exit interviews had a mix of closed and open ended items to explore client experience in the clinic related to service supply and responsiveness, previous experiences, opinions about the NHIS, and suggestions for making the NHIS more responsive.

Sampling

Sampling was purposive. Participants for the national level key informant in-depth interviews were selected from the list of designers of the G-DRG payment method [28]. For regional and district primary data collection, we stratified the country into three zones of relatively similar socio-economic characteristics, namely Northern (Upper East, Upper West, and Northern regions); Central (Brong Ahafo and Ashanti regions), and Southern (Volta, Eastern, Greater Accra, Central, and Western regions). Within the Central zone the Brong Ahafo region was purposively selected because the on-going pilot of capitation in the Ashanti region would make it difficult to evaluate incentives inherent in the nationwide payment systems as against capitation pilot effects. Within the Southern ecological zone, the Greater Accra region was purposively selected because of its peculiarity of being 90% urban with a large and active private self-financing provider community and the lowest average poverty levels in the country. Within the three Northern regions, which have the highest percentage of rural populations and poverty levels in the country, the Upper West Region was randomly selected by balloting since there was no clear rationale to justify purposive selection.

Within each of the three regions, a list of the most recent local government demarcation and classification of districts with districts stratified into rural, municipal, and metropolitan was obtained. One district in each category was selected per region by balloting. Greater Accra was the only region with metropolitan districts and a sub-metropolis in Accra was selected by balloting. The NHIA office covering each selected district was included in the sample.

In the selected districts, a list of government, CHAG, and private self-financing facilities was obtained from the Ghana Health Service and one NHIA accredited district

Table 1 Geographic location of primary data collection (level, facility type, and ownership), method of data collection, and numbers of respondents

Level (National, Regional, District/Municipal/ Sub-metro)	Number of respondents						
	Facility name	Facility type	Ownership	Key informant in-depth interview	Client exit interview	Client waiting time assessment	Client prescription analysis
National	Not applicable	Not applicable	Not applicable	14	0	0	0
Ashiedu Keteke sub-metro	Ussher polyclinic	Polyclinic	Public (GHS)	2	35	35	35
	PML Children's hospital	Hospital	Public (GHS)	0	33	34	34
	Cathedral clinic	Clinic	Private (PSF)	0	35	25	25
	Ashiedu Ketete district scheme	Purchaser	Public (NHIA)	1	0	0	0
La Dadekotopon sub-metro	La General hospital	Hospital	Public (GHS)	2	35	37	37
Madina La Nkwantang municipality	Pentecost hospital	Hospital	Private (CHAG)	2	35	34	34
	North Legon hospital	Hospital	Private (PSF)	2	31	22	22
	Madina Polyclinic (New Road)	Polyclinic	Public (GHS)	2	35	35	35
	Ga municipal scheme	Purchaser	Public (NHIA)	1	0	0	0
Ada East District	Ada HC	Health centre	Public (GHS)	2	35	35	35
	Pute CHPS	CHPS	Public (GHS)	2	5	4	4
TOTAL Greater Accra Region				30	279	261	261
Dormaa municipality	Amasu HC	Health centre	Public (GHS)	2	10	11	11
	Twumkrom CHPS	CHPS	Public (GHS)	2	0	0	
	Dormaa Presby Hospital	Hospital	Private (CHAG)	2	30	23	23
	Saviour clinic	Clinic	Private (PSF)	1	13	13	15
	Dormaa district scheme	Purchaser	Public (NHIA)	1			
Dormaa West district	Nkrankwantakrom	Health centre/DH	Public (GHS)	2	29	39	39
	Kojo Kumi Krom	Health centre	Private (CHAG)		29		
	Yaa Krom HC	Health centre	Private (CHAG)	2	16	2	2
	Kwakuanya Ebenezer Methodist	Clinic	Private (CHAG)	1	0	0	
	Kyremesu Presby HC	Health centre	Private (CHAG)	2	3	18	18
	Kwabenadwomo	Health centre	Public (GHS)	2	13	0	
TOTAL Brong Ahafo Region				17	143	106	108
Sissala East district	Tumu hospital	Hospital	Public (GHS)	2	35	37	37
	Wellembele HC	Health centre	Public (GHS)	2	16	19	19
	Nnamdouonu CHPS	CHPS	Public (GHS)	2	7	8	8
	Mama Mary	Clinic	Private (PSF)	2	18	22	22
	Sissala East district scheme	Purchaser	Public (NHIA)	1	0	0	0
Wa municipality	Kambali HC	Health centre	Public (GHS)	2	30	37	37
	Tampalipani CHPS	CHPS	Public (GHS)	2	4	4	4

Table 1 Geographic location of primary data collection (level, facility type, and ownership), method of data collection, and numbers of respondents (Continued)

	Islamic hospital	Hospital	Private (PSF)	2	35	26	32
	Wa Municipal scheme	Purchaser	Public (NHIA)	1	0	0	0
TOTAL Upper West Region				16	145	153	159
GRAND TOTAL				63	567	520	528

GHS, Ghana Health Service; PSF, Private Self-Financing; CHAG, Christian Health Association of Ghana; CHPSC, Community Health Planning and Services Compound; NHIA, National Health Insurance Authority.

hospital, health centre, and CHPS compound in the public sector were selected by balloting. Where the district had CHAG and private self-financing facilities, one CHAG and one private facility were selected by balloting if there was more than one; if there was only one it was selected. During data collection, some selected facilities had to be substituted with the nearest facility of the same category because the information in the national level facility listings did not always reflect what was happening at the frontline and the selected facility was no longer functional.

Data collectors visited each clinic starting at the morning shift hours of 8.00 am. All clients entering the clinic – regardless of insurance status – were tracked for time spent at the different service points until a maximum of 35 clients was reached. Some of the smaller clinics had low client loads and it was not possible to get 35 clients in one day but the time frame and budget of the study did not allow repeat visits. Prescriptions issued to these clients were copied for analysis, and an exit interview administered. Ethical clearance was obtained from the Ghana Health Service Research and Development division; all tracking and interviewing was done with informed consent.

Data analysis

The study was carried out in response to a request by the Ghana NHIA for an evaluation of its DRG payment methods. The constraints of the time frame of the request meant that the data collection and analysis was done using overlapping processes. The team had mixed qualitative and quantitative data collection and analysis skills among the members. The same two members of the research team did all the national level in-depth interviews and, together with a third team member, they performed the qualitative analysis. For the district level primary data collection, the research team split into three groups to collect data with support from research assistants.

Apart from notes during the interview, in-depth interviews were recorded and transcribed. Analysis was manual to identify themes, commonalities, and contrasts. The open-ended questions in the exit interviews were typed into Excel, coded, and classified by themes and sorted for analysis. Primary quantitative data analysis

was done in Excel and Stata. Routine health management information system data was analysed in Excel. We used frequencies, cross tables, and trend lines for the quantitative data analysis. Team members were assigned responsibility for analysing particular data sets depending on their expertise.

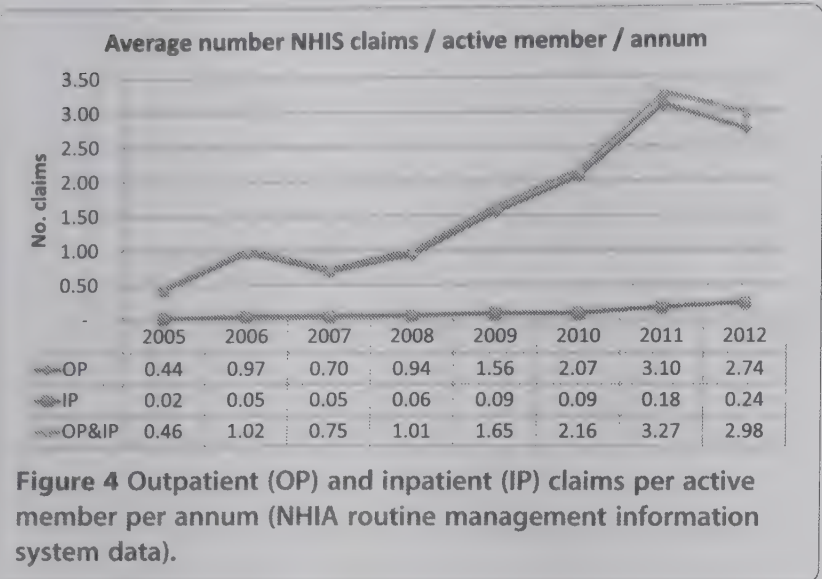
To help generate a more holistic theory as to the relationships between provider payment methods, service supply incentives and behaviour, and what mechanisms explain these observed effects, we used causal loop and causes tree diagrams [29] – both systems thinking tools.

Validity, quality assurance, and limitations

Several methods were used to ensure validity. Firstly, we have presented our methods in detail to enable readers to judge the quality of the data. Secondly, the whole team discussed analysis and conclusions from each data set, and findings from different data sets related to the same question were compared as part of triangulation and minimizing individual team member biases. This also allowed a more reflexive approach to data analysis. Thirdly, we paid attention to extreme as well as middle cases in our analysis and did not focus on frequently repeated responses only. Fourthly, before finalizing our report, we organized two different half-day validation meetings with representatives of our respondents to present our initial analysis and conclusions and obtain their feedback. This was part of the iterative process of data collection and data analysis. We also made our draft report available to respondents who were willing to read it, to check if it was valid from the perspective of their experiences that we were trying to describe and analyse.

Findings and discussion

We used trends in utilization for insured and uninsured to assess changes in supply related to the number of clients seen by providers. The data is summarized graphically in Figures 4, 5, and 6. Both the provider and purchaser data sets tell the same story of increased numbers of visits per active insured member for inpatient and outpatient services. There does not appear to have been a similar change over time in the number of visits to formal providers for the uninsured. Data was not available to enable



an assessment and comparison of trends in visits to non-formal providers.

The insurance status of the clients participating in our exit interviews showed the same pattern of a dominance of utilization of formal services by the insured. Of the total of 567 clients in the exit interviews, 432 (76%) had a valid insurance ID card.

It is, however, difficult to come to any firm conclusion from the data available that this utilization reflects incentives for providers to preferentially see insured clients or is due to service provider (supplier)-induced demand. There are several possible reasons related to demand as well as supply that could explain the data. These include the increases in utilization among the insured reflecting increased client demand induced by the removal of the financial barrier and frivolous use by insured clients also related to the removal of the financial barrier. It could, however, also reflect some supplier-induced demand. Several respondents in our national level qualitative interviews mentioned that, for any given illness episode, the G-DRG design allows a provider to bill for three visits for outpatient care – the initial visit and two follow-up visits.

It could be to the financial advantage of the provider to bill routinely for all three visits regardless of whether the client needed or even made them.

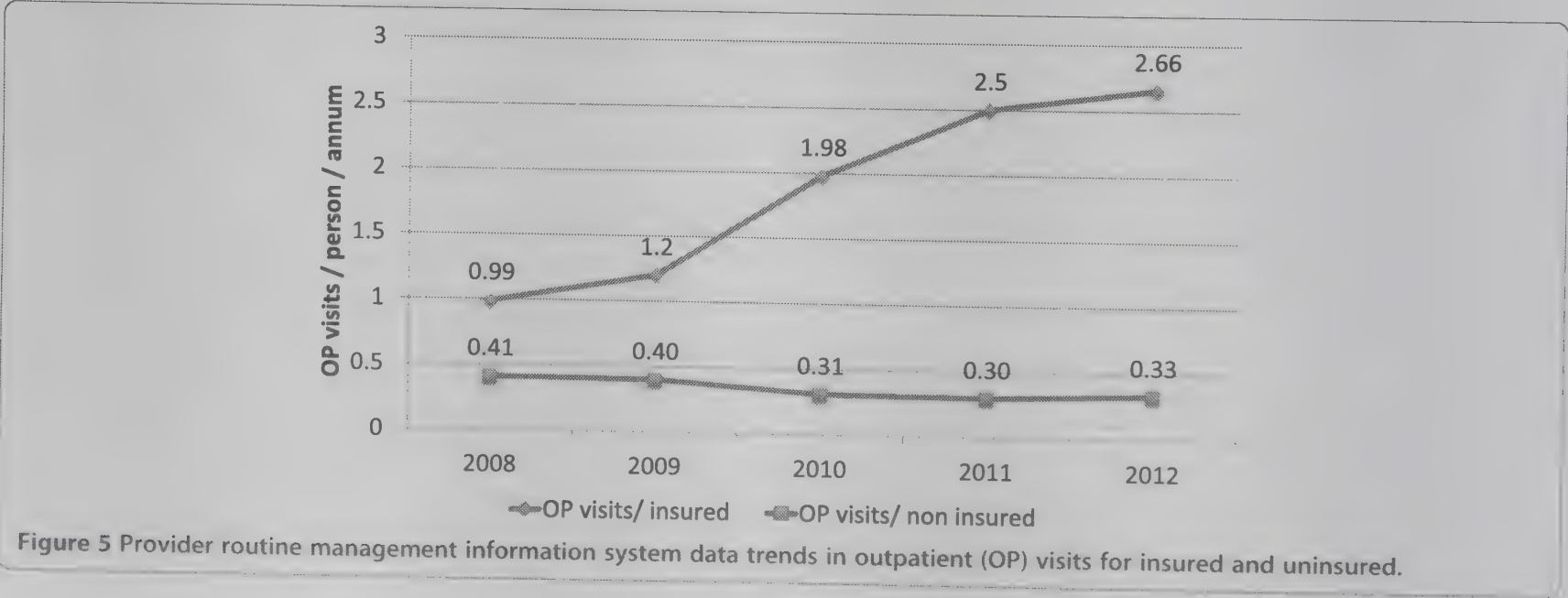
Making it even more difficult to conclude on supplier-induced demand as a major reason for the increased numbers of encounters per insured client is that our key informant interviews with frontline providers suggested that the G-DRG is leading to some shifting of cases in the form of referral. The quote below illustrates this as well as the impression we got that there was a disincentive to see certain kinds of insured clients because providers felt the reimbursements were inadequate for the inputs needed to manage the case.

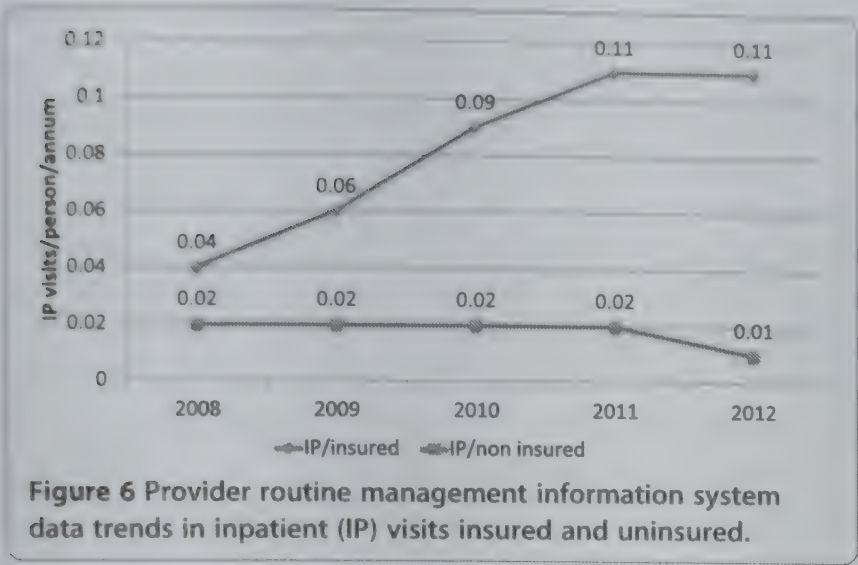
“...you can imagine somebody bringing an ulcer... you know that (dressing) a big sore daily... the cost will go up so you will lose... so we were losing, so that was why most of us were not dressing this thing, we refer them to the hospital... yes, even the suturing too was a problem; the money was just a token.” Rural Health Centre nurse

The actual as well as perceived inadequacy of the reimbursement rates were compounded by the delays in reimbursements. To illustrate with the words of a hospital medical superintendent:

“...The payment system has really broken down to a certain extent. They are not consistent with the payments and it is disturbing our work. It makes us financially not sound... Promptness is the bigger problem rather than the rate... If they would pay us promptly I would be so happy.”

These observations lead to other findings on the dimension of supply related to input use per client. The indicators explored to help understand this dimension of provider supply decisions were volume of tests and





procedures, medicines prescribing, and client time spent in facilities.

Volume of diagnostic tests and procedures

Some of the responses obtained from providers and clients suggest that the bundled payments of the G-DRG for services were a disincentive to carry out extensive diagnostic investigations whether they were needed or not, for example:

“...the grouped billing... is a disincentive to carry extensive investigations” Pharmacist, Urban Polyclinic

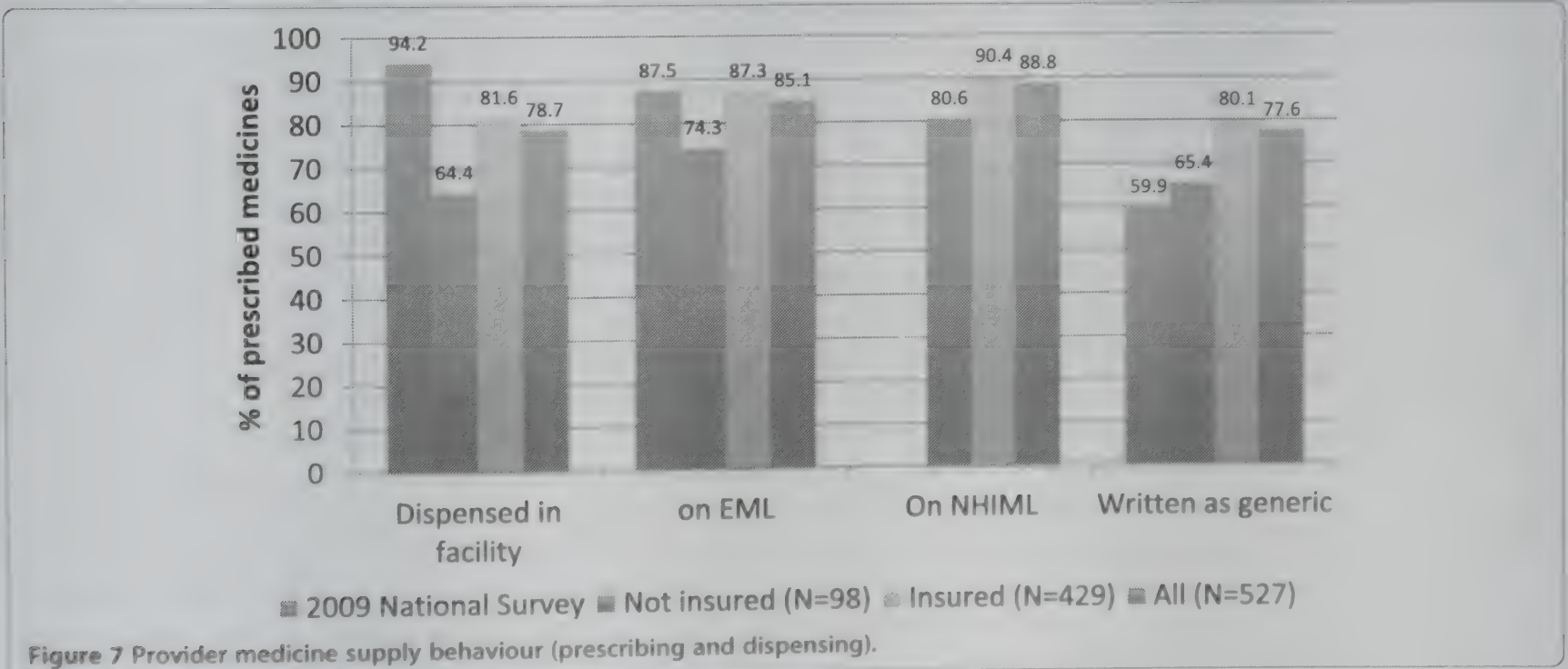
An NHIS subscriber described how he presented for services without showing his insurance card. After his history and examination, he was asked to do several laboratory tests to help confirm a diagnosis. At this point, he mentioned he had an insurance card and asked if that could cover his treatment including the laboratory tests. There was a subtle change in the facial expression of the staff and he was asked why he had not provided this

information earlier. He was then asked to please give his folder back for review and wait. After a while, the folder was brought back to him with the laboratory tests cancelled, and the information that they were not needed. He could just go and collect his medicines.

Medicine prescribing

The literature review of the incentives associated with different payment methods suggests that over or at least adequate provision would be an incentive for the supply of medicines under the NHIS, given that an itemized fee for medicine schedule is the payment method. Our data sometimes suggested, but was not always convincingly in support of, a situation of adequate or over rather than under provision of medicines. The average number of medicines per outpatient prescription in our sample was four for all prescriptions (n = 527)^a, three for the non-insured (n = 98), and four for the insured (n = 429). The most recent national data on prescribing indicators available for comparison was the pharmaceutical situation assessment carried out in May/June 2008 [30]. It unfortunately did not compare data between insured and uninsured. The average number of medicines per prescription in this survey was four.

Other prescribing indicators from our survey are summarized in Figure 7 and compared with data from the 2009 national survey. There was no data on whether medicines were on the NHIML in the 2009 survey. It would be expected that facilities would supply nearly 100% of the medicines prescribed from their dispensaries since, in theory, the more medicines supplied, the more income the provider earns. In our survey, however, only 78.7% of medicines prescribed were dispensed in the facility. A higher percentage was dispensed in the facility to the insured (81.6%) as compared to the uninsured



(64.4%). However, as Figure 7 shows, compared to the 2008 national survey data where 94.2% of all medicines prescribed were dispensed in the facility, the percentage of medicines prescribed that were dispensed in the facility, whether to insured or uninsured, is low. It raises questions as to whether something other than insurance status and provider payment method is modifying prescribing and dispensing behaviour.

The NHIS policy requires that medicines are prescribed by generic name and are on the NHIML, otherwise they do not qualify to be supplied “free” under the NHIS. As Figure 7 shows, there was higher prescribing of medicines by generic name and from the NHIML for insured as compared to uninsured clients. It is reasonable to suspect that this is an influence of the provider payment method and its associated rules. However, in spite of these rules, not all medicines for insured clients were prescribed by generic name or listed on the NHIML. It would appear that something else is also influencing behaviour. The influence is probably bigger for the uninsured who do not have the effect produced by the rules of the NHI provider payment method. Our data does not allow a complete explanation of what is causing these prescribing and dispensing behaviour gaps, which are wider for the uninsured than the insured. We can only make some guesses based on our observations. One of them is that providers repeatedly complained that the reimbursement rates for some medicines on the NHIML are too low. Perhaps, the actuality as well as the perception of too low tariffs could negate, in part, any incentives to prescribe and dispense such medicines. Secondly, weaknesses in the implementation of the rational use of medicines policy in Ghana could also explain the uninsured data. The rational use of medicines policy requires that all medicines are prescribed by generic name and are listed on the Essential Medicines List. The Essential Medicines List and the NHIML overlap, but not completely. Finally, the condition of some patients may just have required medicines to be prescribed outside the NHIML and the Essential Medicines List, and which were not available as generic. It is doubtful, however, if such cases at the outpatient primary care level should account for as many as 10 to 25% of prescriptions.

The exit interview data confirmed the failure to supply all medicines prescribed in the facility dispensary and also showed insured client discontent with this failure. Of the 41 clients in the exit interviews (7% of the total sample) who felt the NHIS was bad, a little over half (22) gave a reason related to the failure to supply all medicines prescribed free as part of their NHIS benefits. Examples typical of these responses include:

“The aspect where the scheme does not cover all the drugs is worrying to us especially we the poor...”

“They do not give all the drugs”

“Buying drugs outside the hospital while you still have a valid insurance”

“...dislike the NHIS because initially it was supposed to be free but now I’m made to buy drugs anytime”

Some out of pocket payments by insured clients is not a new finding; as many as 94% of respondents in the Ghana Demographic and Health Survey [13] reported sometimes making out of pocket payments for medicines, services, or both. The SHINE project also documented insured client out of pocket payments. They were, however, significantly lower than uninsured client payments [31,32]. Some of these out of pocket payments are for services and medicines not covered by the NHIS. Others are related to managerial inefficiencies, e.g., stock outs, and others to reluctance to stock and supply NHI clients with items that are seen as potentially causing financial loss to the provider because of unattractive NHI tariffs.

Time spent with patients

It was not clear that time spent in the clinics by clients was related to provider payment incentives. Client loads and staffing constraints rather appeared to be the influences over it. Figure 8 summarizes total time spent by facility. The longest waiting times were in the crowded mission (CHAG) and public (Ghana Health Service) hospitals, polyclinics and health centres. The private hospitals and clinics and the CHPS compounds where we recorded the lowest times spent by patients in getting care were also the facilities in which we observed lower client numbers.

Pulling it all together

We have qualitatively explored some answers to questions related to the “what” and the “why” of service supply behaviour and incentives related to provider payment methods of the Ghana NHIS. To answer the “what” question, we have conceptualized and described service supply behaviour in two dimensions of numbers of insured clients and inputs into management of individual clients seen. To answer the “why” question, we have drawn upon systems thinking and realist evaluation theories and examined the wider national context, the health system, and their influence. We now pull these pieces together to generate potential explanatory theory employing the systems thinking tool of causal loop and causes tree diagrams qualitatively. Figure 9, a causal loop diagram, is our concluding theoretical model. Since the diagram is qualitatively constructed, it provides no indication of magnitude of effect.

Total time spent in the facility
(mins)

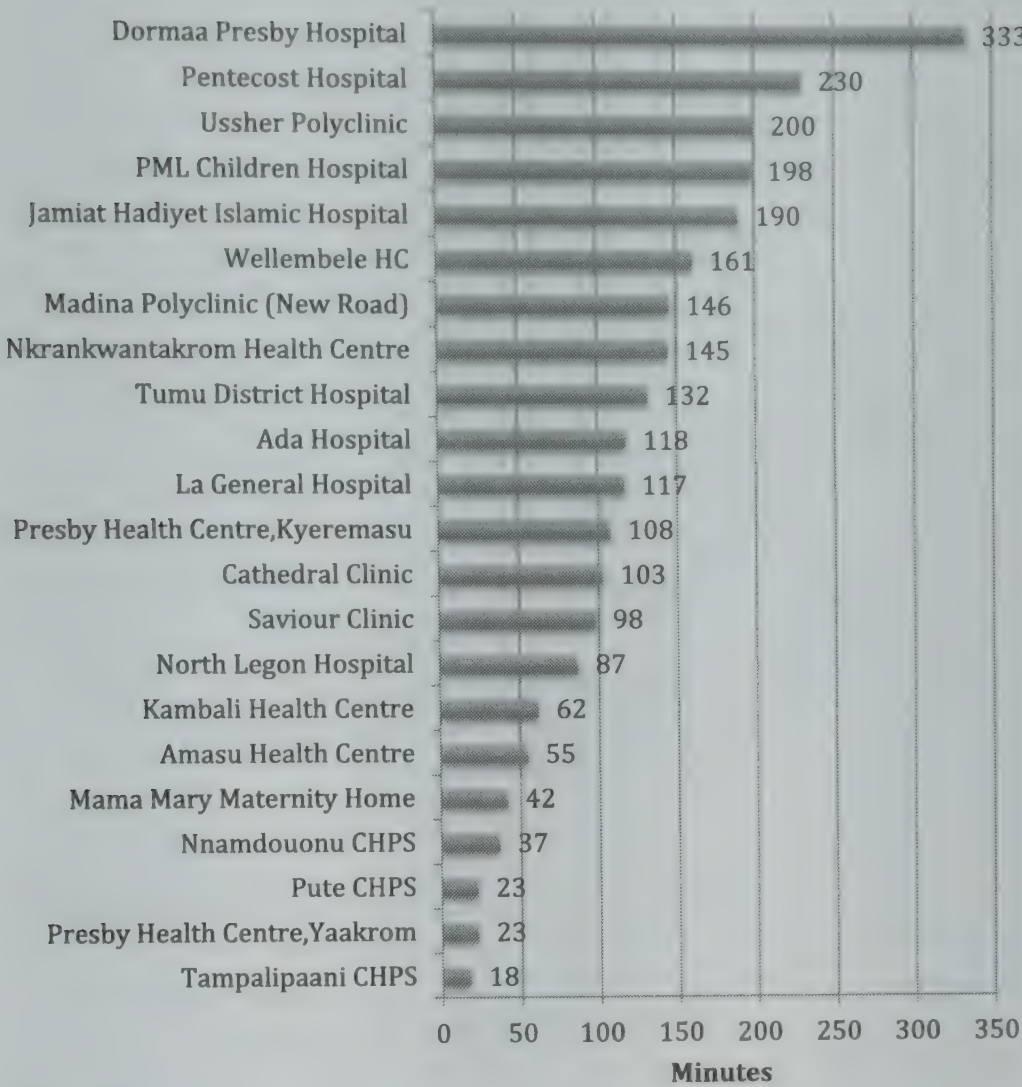


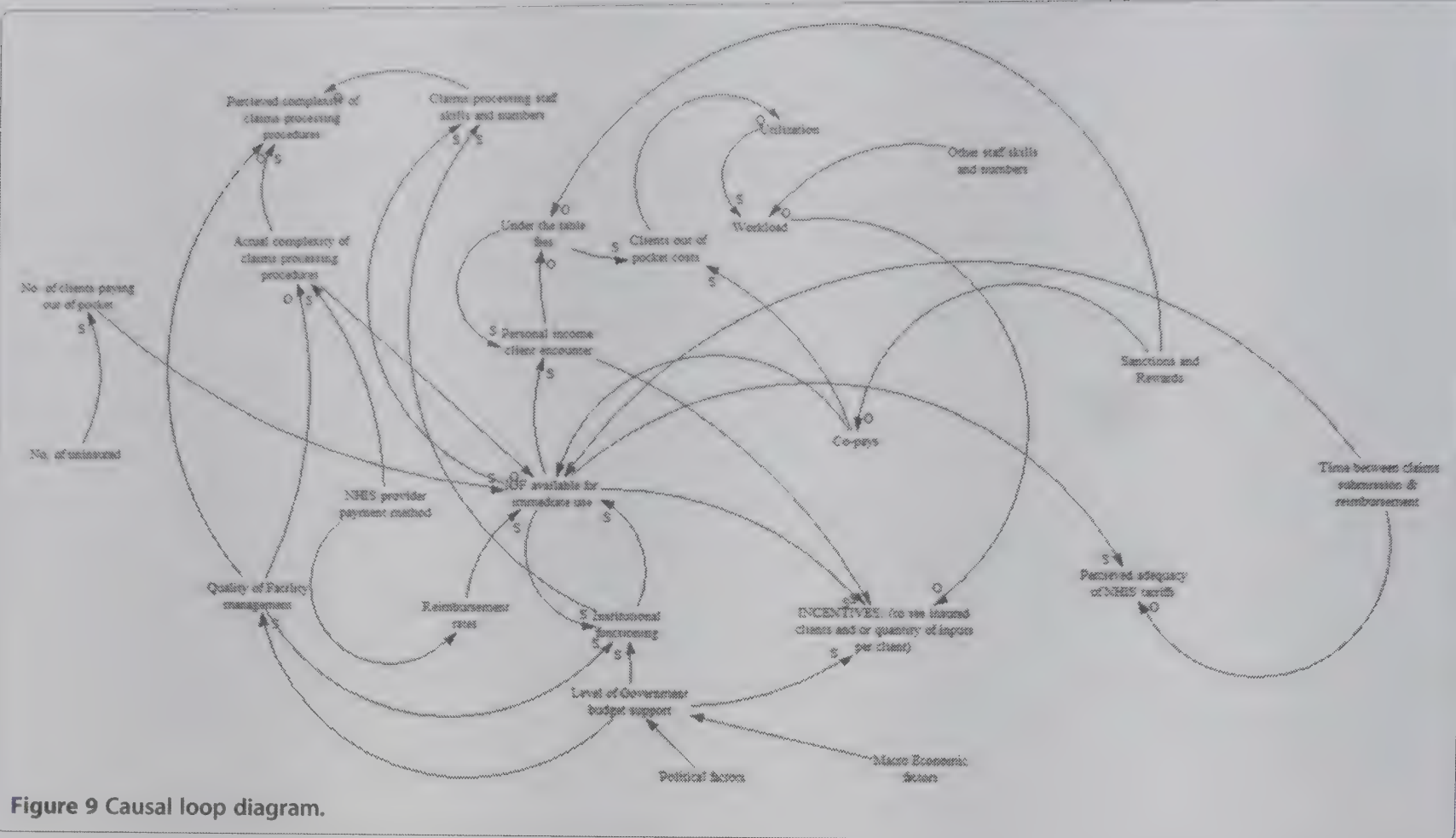
Figure 8 Total time spent by facility.

As for any causal loop diagram the theorized direction of influence of one factor on the other is show by the direction of the arrow. The labels at the tips of the arrows indicate whether the influence is to cause a decrease or increase in the level of the influenced factor. An “S” sign against the arrow head means that, as the causal variable increases or decreases, the influenced variable changes in the same direction. An “O” sign means the change is in the opposite direction. Where there is neither an “O” or an “S” sign, the relationship is something other than a straight forward increase or decrease.

Thus, for example in Figure 9, we theorize that the amount of internally generated funds (IGF) available for immediate use through NHI payments influences incentives to supply service to insured clients. IGF is a term used in Ghana to describe funds that are generated and retained for use at the facility level as compared to ‘external’ funds such as Central Government allocations. IGF comes from NHI payments, out of pocket fees, and, in a few instances, reimbursements from corporations and agencies on behalf of their workers. For private

sector facilities it is their entire source of income. For public sector facilities it forms 80% or more of their income for recurrent expenditure [33]. The more IGF is, the more incentivized providers are to supply services to insured clients in both dimensions. Out of pocket payments have an immediate effect on IGF availability unlike NHIS payments whose effects are modified by the time lag between claims submission and claims payment. Additionally, IGF availability from insured clients is affected by the perceived and actual complexity of claims processing procedures of provider and purchaser. Complex procedures tend to take more time to fulfil and can increase the time lag to final payment. They also require more skilled staff numbers and time and may be more likely to lead to mistakes in claims submission by providers as well as auditing by the purchaser that lead to denial of claims.

Causal loop diagrams are difficult to follow for those who have not been involved in the details of constructing them. To make the causal loop diagram easier to follow, we have unpacked its core into a series of cause



tree diagrams in Figures 10A–E. Figure 10A shows factors that we theorize from our observations to have a direct influence on supply incentives. These are IGF available for immediate use, level of general budget support provided by government for service delivery, personal provider income per client encounter, and workload. Factors that directly influence each of these factors are unpacked in cause tree diagrams 10B–E.

There does not appear to be a linear relationship between provider payment method and incentives to see more active NHIS card holders or provide more inputs per client. The relationships are indirect and modified by contextual factors. Some of the different factors are controlled by different agents or actors, with some controlled by multiple agents. A reinforcing loop in the causal loop diagram is the link between institutional functioning and IGF available for immediate use. We theorized that better-managed facilities might be better able to find ways of coping with the resource constraints of the health system. Improved resource availability was likely to reinforce better management.

The observed status of many of the variables would produce a tendency to prefer out of pocket paying clients to clients who are paid for by insurance and to contract some but not all service inputs to insured clients. Our data does not allow us to answer the question of whether the current levels of inputs per client are adequate. More services do not necessarily translate into high quality and responsiveness. However, it is doubtful if a tendency to incentivise contraction of service inputs

in a system of resource scarcity will ensure high quality and responsiveness.

Conclusions

In our study setting, service supply behaviour and the incentives driving it cannot necessarily be predicted in abstract from the theory about the anticipated response to a given payment method. The wider national context as well as characteristics of the health system into which the method is introduced shape and modify supply behaviour and incentives. This is not surprising given that the payment method reforms have been introduced into a complex adaptive system. The individual agents (whether institutions, persons or groups) in such systems are interconnected and have the freedom to act in ways that are not always predictable. Whether ignored or acknowledged, complexity remains and affects outcomes in such systems. To be able to cope, it is better to recognize, understand and try to work with complexity rather than engage in the futile effort of trying to “reduce” it with linear approaches [34,35].

Provider payment reform in low- and middle-income countries should pay at least as much, if not a little more, attention to context of the reform and the potential interactions between the reform and context and the resulting intended and unintended effects as to the method itself in the design and implementation of reform.

Finally, Gauri [36] has observed that “data limitations, selection effects and numerous confounding variables”

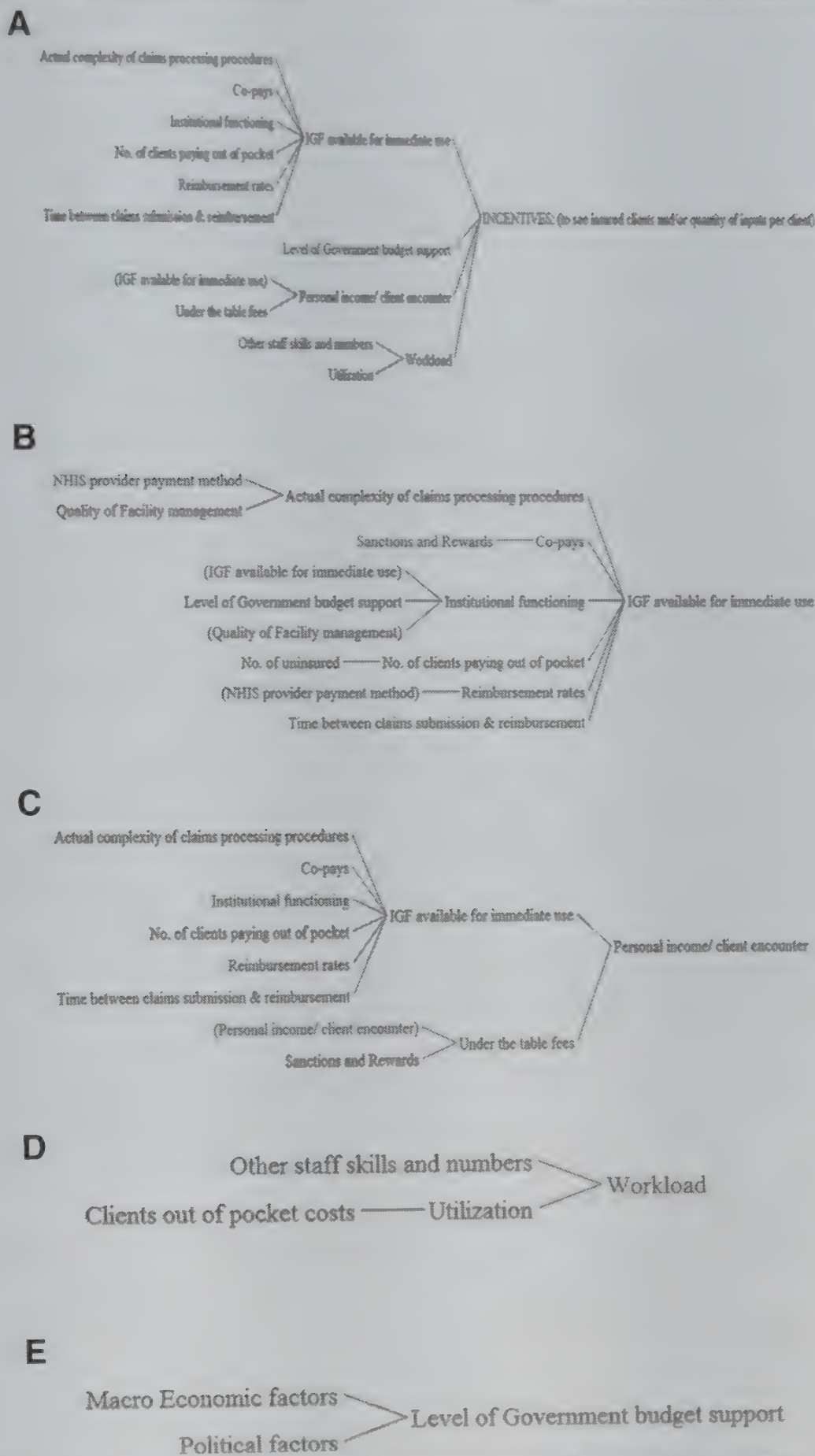


Figure 10 (A) Factors influencing service supply incentives. (B) Factors influencing IGF available for immediate use. (C) Factors influencing personal income per client encounter. (D) Factors influencing workload. (E) Factors influencing level of direct government budget support to providers.

make study difficult and limits the availability of empirical research on provider payment mechanism effects on providers in low- and middle-income countries. We agree from our experience and make a plea for continued work on methodological approaches in such settings.

Endnote

^aPrescriptions transcribed with missing data dropped from the analysis accounts for the difference between the total number of prescriptions in the sample (528) and the number of prescriptions from which analysis is presented (527).

Abbreviations

CAS: Complex Adaptive Systems; CHAG: Christian Health Association of Ghana; CHPS: Community Health Planning and Services; G-DRG: Ghana Diagnostic Related Groupings; IGF: Internally Generated Funds; NHI: National Health Insurance; NHIA: National Health Insurance Authority; NHIML: National Health Insurance Medicines List; NHIS: National Health Insurance; SSNIT: Social Security and National Insurance Trust; UHC: Universal Health Coverage.

Competing interests

The authors declare that they have no competing interests.

Authors' contribution

All authors contributed to study design, data collection, and analysis. IAA conceptualized and wrote the paper. All authors read and commented on the draft. All authors read and approved the final manuscript.

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RESEARCH

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Advancing the application of systems thinking in health: managing rural China health system development in complex and dynamic contexts

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Abstract

Background: This paper explores the evolution of schemes for rural finance in China as a case study of the long and complex process of health system development. It argues that the evolution of these schemes has been the outcome of the response of a large number of agents to a rapidly changing context and of efforts by the government to influence this adaptation process and achieve public health goals.

Methods: The study draws on several sources of data including a review of official policy documents and academic papers and in-depth interviews with key policy actors at national level and at a sample of localities.

Results: The study identifies three major transition points associated with changes in broad development strategy and demonstrates how the adaptation of large numbers of actors to these contextual changes had a major impact on the performance of the health system. Further, it documents how the Ministry of Health viewed its role as both an advocate for the interests of health facilities and health workers and as the agency responsible for ensuring that government health system objectives were met. It is argued that a major reason for the resilience of the health system and its ability to adapt to rapid economic and institutional change was the ability of the Ministry to provide overall strategy leadership. Additionally, it postulates that a number of interest groups have emerged, which now also seek to influence the pathway of health system development.

Conclusions: This history illustrates the complex and political nature of the management of health system development and reform. The paper concludes that governments will need to increase their capacity to analyze the health sector as a complex system and to manage change processes.

Keywords: Health system, Institutional development, Rural health finance, System resilience

Background

China created a system of rural health care finance during the period of the socialist planned economy (1949 to 1978), when the level of economic development was very low, and a large proportion of the population lived in poverty. The Cooperative Medical System (CMS) provided basic health benefits to most rural farmers. By 1976, more than 90% of rural villages had a CMS and a network of preventive and curative health facilities at county, township, and village levels. Most services were provided by “barefoot doctors”, who had limited training

but provided timely and low cost treatment to rural residents [1]. They were supervised by medical doctors and they could refer patients to county hospitals. This rural health system contributed to significant improvements in access to basic health services and in health outcomes [2]. This rural health finance system collapsed during China’s transition to a market economy, which began in 1978. During the 1980s and 1990s, efforts were made to rebuild it, with little success. However, starting in 2002, the government began to implement so-called New Cooperative Medical Schemes (NCMS) and, by 2012, 805 million rural residents, or 98% of the rural population, were covered by NCMS [3].

This paper explores the evolution of CMS and NCMS since the late 1970s as a case study of the long and

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complex process of health system development. It argues that its trajectory has been the result of the response of large numbers of agents to a rapidly changing context and of efforts by the government to influence this adaptation process. It draws on the concept of resilience, which Walk et al. [4] define as “*the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks*”. It concludes that the way that the government manages the adaptation of the health system to rapid change strongly influences the degree to which it meets socially agreed objectives of providing access to safe and effective services for all [5].

Applying system thinking to health care systems: a literature review

Understanding health care systems as complex adaptive systems

There is a growing interest in applying concepts of complex adaptive systems (CAS) [6-14] to the analysis of health systems. A CAS has many components, often called agents, which interact in apparently random ways [15]. Through these interactions, patterns emerge and the system is continually self-organizing through processes of emergence and feedback. Agents in the system are ignorant of the behavior of the system as a whole, responding only to local information [16-19]. Policy-makers, who want to implement a new policy and overcome resistance [13], need to pay attention to the context, the behavior and networks of agents, and likely feedback loops [20].

A number of case studies in the advanced market economies have applied CAS concepts to different aspects of health system performance, such as disease control [21], nursing homes [22], palliative care [23], family practices [24], and primary care [25-28], in designing evaluation research [29-33], in interpreting research findings [34,35], and in other health system areas [36-39]. These studies have increased our understanding of the role and behavior of agents involved in health systems.

There are a growing number of studies of health systems in low- and middle-income countries. Many of these countries have weak institutional arrangements in comparison to the advanced market economies and this influences how policy is translated into changes in system behavior [40]. Xiao et al. [41] explore this with regard to China's implementation of an essential drugs policy. They demonstrate that the interaction of responses by different actors has led to divergent and unpredicted outcomes. They conclude that the management of policy change in rural China needs to take into account the emergence of adaptive and self-organized behavior and that many changes are nonlinear.

Paina and Peters [42] offer a macro perspective on strategies for taking health system changes to scale. They

examine the impact of system history, context, and political and institutional structures on the complex pathways of change. The interactions of system components and phased change and transitions are important aspects of successful scaling up of health services. The authors conclude with a call for more research on the management of health system transition and adaptation to changing contexts.

The long, dynamic, and complex process of health system development

It is important to understand the performance of a health system in its broader context. This is especially important in countries, like China, which are in the midst of a number of rapid and interconnected changes. Work on health system development can draw on a substantial body of work, which applies the lens of resilience thinking and CAS to studies of changes in social-ecological systems. Resilience thinking offers a good framework for examining the long, dynamic, and complex process of system change. Folke et al. [5] argue that adaptation and transformation are essential for maintaining system resilience. They view adaptability as the capacity of actors in a system to influence resilience and transformability as the capacity to create a fundamentally new system. They differentiate between two types of transformation. Forced transformation happens at a scale beyond the influence of local actors and is imposed by external forces. Another type of transformation is the deliberately initiated transformational process by people involved at multiple scales and can lead to feedback effects that conclude in whole system change.

The literature on adaptive management and transition management has roots in CAS theory [5]. Adaptive management is concerned with the establishment of a continuous learning process that responds to new information by reformulating hypotheses and models, and understanding policy implementation as experiments. Transition management is concerned with the dynamics of structural change of the system. There is a spectrum between adaptability and transformability from the lens of resilience. Identifying the key transition points and understanding the mechanisms of how system transformations are initiated, facilitated, and influenced can help us understand the health system development process.

Gell-Mann argues that it is important to differentiate between what is adaptive and the outcome of a process of adaptation [17], he maintains that the latter can be maladaptive due to the influence of selection pressures. From a system evolution perspective, it is crucial to understand the impact of individual adaptations for system goal achievements, system resilience, and choices of system transition [43]. The mal-adaption is similar to policy resistance discussed by Tan et al. [14]. This paper

applies these concepts to the analysis of the pathway of development of China's NCMS system over three and a half decades. It explores what has triggered transitions and how adaptation by agents has played an important role in driving change. It also explores how the Ministry of Health has attempted to maintain system resilience by enabling agents to adapt to a changing macroeconomic context while acting to ensure that the system maintained its function and achieved agreed policy goals.

Methods

This study is a retrospective review of the development of the rural health system over three and half decades. We decided to focus on NCMS for several reasons. First, the authors have already undertaken research on NCMS, and several participated in the implementation process or served as advisors to government. Second, the authors have access to key informants who were involved in the policy process. Third, the first author is on the National Healthcare Reform Expert Committee. This committee includes representatives of all relevant government agencies including the State Development and Reform Commission, the Ministries of Health, Finance, Civil Affairs (for the poor), Human Resources and Social Insurance, and so forth.

An insider's perspective has strengths and limitations. Being part of the change process provides information on the "black box" of policy negotiation and decision-making, and the core issues being debated. It can also provide insights on the thinking of top decision-makers when they were in the conference rooms. However, these impressions might not be accurate, and they may be influenced by a number of biases. Realizing the pros and cons of the core data sources, this case study selected supplementary sources of data to minimize the potential risk of bias.

We approached the former Minister of Health whose tenure ended in 2003. We asked him to identify key informants who had gone through the longest period of NCMS development. We identified four key informants including the former minister, the rural health bureau director, the NCMS office director, and the former Shan'xi province Director of Health Bureau. We asked the four key informants to define stages of the development of NCMS from their own perspective, and identify the key "transition points" for system change. The four informants provided similar answers which were based on the changes of the national agenda for development. Based on the key informants, we built a detailed picture of NCMS system development stages and transitions.

The key informant interviews pointed to the close relationship between health system change and the national development process, and national development priorities. To use the language of CAS, the context plays

a key role in driving system transitions. To test this hypothesis, we began to collect and review all national policy documents on CMS and NCMS. China has issued 92 national policies addressing rural health systems. To better understand the national development priorities, we reviewed the memoirs of the former premier Zhu Rongji, and interviewed the former health minister on his reflections of the national policy priorities.

We paid particular attention to the policy environment and public policy priorities at each "transition point" to understand the interplay between health policy and national development agenda transitions. We developed a semi-structured questionnaire to conduct a second round of interviews of the key informants on the processes of multi-agency bargaining and negotiation, and to identify the key determinants for making the "transition" happen. The data on adaptation mainly came from three sources. First, we interviewed the NCMS office director, two provincial (Shan'xi and Hubei) health bureau directors, and three county health bureau directors to learn the process of the NCMS policy formations and implementation. We also reviewed internal reports on NCMS, collected statistics of rural health system elements based on the government health information system, and the policies issued by the national government and the health ministry on NCMS. The third source is the large body of published literature on NCMS. All interviews took place between January 2013 and January 2014. Finally, to understand the status changes of NCMS, we traced the policy documents on rural China development. Each January, the State Council of China issues the 1st National Policy Document, and historically, all 1st Documents concern rural development, including health, education, social security, agriculture, etc. We hoped that through this method, we would have a full picture of China's NCMS development.

It is important to keep in mind the relatively narrow focus of our data collection on the perspectives of health sector policy actors. We have not attempted to collect information on the perspectives of providers or users of health services. Nor have we explored the points of view of senior policy actors outside the health sector. Despite these limitations, the study provides a useful insight into the challenges of managing the adaptation of a health system to a rapidly changing context, as seen by those most directly responsible for providing policy leadership.

Results

Starting in the late 1970s, rural health finance went through three main transitions. Each was a forced transition [5], because it was largely determined by a shift in the national development agenda and in the understanding by the top leaders' of the key issues concerning rural health system development. The adaptation processes

after each transition were strongly influenced by an iteration between responses by a multitude of individual agents and government efforts to revise the rules of the game, through a series of policy initiatives. Table 1 summarizes the transition and adaption process of NMCS. Detailed analysis follows.

First transition and adaption to outside pressures between 1978 and 2002

The initial forced transition (from the planned economy to the market economy) took place in the late 1970s. Launched in late 1978, China’s economic reforms promoted a system of household responsibility. Land that had previously been collectively owned was allocated to individual households. The introduction of the household responsibility system was a significant contributor to the collapse of CMS, since townships could no longer allocate a share of collective production to the scheme [44]. In addition, low levels of public funding of rural health, design, and management flaws of CMS, and the lack of consensus about the future of CMS accelerat-

ed disintegration of the program. In the 1980s, CMS coverage fell to less than 10% of rural residents, with the lowest rate at 5% [2,45,46]. At the same time, the government ended its policy of requiring skilled health workers to remain in rural facilities. Over time, the Ministry of Health became aware of a number of problems with rural health services, such as rising costs of medical care, shortages of skilled personnel, and the resurgence of previously eradicated or controlled infectious diseases [44,47].

The priorities of the Ministry of Health during this period were to maintain the effectiveness of the health system in meeting agreed policy goals with regard to access to services, while ensuring that health facilities remained financially viable. It pursued the latter by allowing service providers to use “market tools” to generate revenue to pay their workforce [48]. Between 1978 and 1989, the policies issued by the Ministry of Health primarily focused on maintaining the financial viability of public health organizations and ensuring that health workers were paid. From the end of 1978 to the summer

Table 1 Transition and adaption of NCMS

Time period	Events	Notes
1950s to 1978	The origin and development of the Cooperative Medical Scheme (CMS)	CMS: System History
Dec. 1978	China’s market oriented economic reform promoted a system of household responsibility	Transition Point I
1978 to 1979	The Ministry of Health (MoH) issued five national policies to strengthen rural health care facilities and organizations in staff compensation, training, management, investment, and subsidies to health facilities	Adaption Process I
1980s	The CMS collapsed rapidly due to lack of support from the collective economy in rural China and other reasons The MoH issued many documents on rural healthcare workforce and their compensations, such as retirement and pension calculation, subsidies, private clinic permissions, support to barefoot doctors, service fee charges for immunization work done by the grassroots clinics and doctors, and service fee charges by sanitation and anti-epidemic stations	
1990s	The MoH Started to rebuild CMS, but the efforts failed for lack of consensus between different government branches and the limited investment to the rural health system	
Oct. 2002	A “Decision on Further Strengthening the Public Health Work in Rural Areas” was issued jointly by the Central Committee of the Communist Party of China (CPC) and the State Council in October 19, 2002. The New Cooperative Medical Scheme (NCMS) was defined as a rural cooperative medical insurance system based on a co-financing system which included volunteer contributions from individuals and financial support from central and local government	Transition Point II
2003 to 2005	NCMS pilots were carried out in approximately 300 counties in order to improve the design of reimbursement plans, the management of funding and services , etc.	Adaption Process II
2006	A large-scale interim evaluation of the scheme was carried out, which helped inform subsequent policy and promote convergence in policy design	
2006 to 2008	The expansion of NCMS in China. The coverage rate of NCMS increased from less than 10% in 2002 to more than 90% in 2008. At the same time, the number of registered doctors, assistant doctors, available beds, and inpatients treated has increased significantly in Township Health Centers and County Hospitals	
2009	The Central Committee of the CPC and the State Council jointly endorsed and issued the Guidelines on Deepening the Reform of Healthcare System after about three years of intense debate and repeated revision	Transition Point III
2009 to present	Policies on Essential Drugs, County Hospital Reforms, Payment Reforms; Integration of NCMS with Urban Health Insurance Systems at local level	Adaption Process II

of 1979, the Ministry of Health issued five national policies to strengthen rural health care facilities and organizations in staff compensation, training, management, investment, and subsidies to health facilities. More policy documents were issued between 1979 and 1988 on the rural healthcare workforce and their payment, such as retirement and pension calculation, subsidies, private clinic permissions, support to barefoot doctors, service fee charges for immunization work done by the grassroots clinics and doctors, and service fee charges by sanitation and anti-epidemic stations. By allowing the rural healthcare facilities and doctors to charge fees to maintain the delivery of health services, and by allowing the health facilities to improve their management according to the market principles and fighting for more government investment in rural health, the Ministry of Health ensured the viability of the rural health services in the face of major financial challenges [48,49]; it did this whilst maintaining public ownership of these facilities. In addition to the public ownership of the healthcare facilities and the workforce, the professional organizations, such as the Chinese Medical Association and the Chinese Doctors' Association, were all under the management of the Ministry of Health and helped the healthcare workers to negotiate their income, maintain their social status, and influence their behavior.

A few attempts were made to rebuild CMS but they did not result in changes at scale because of conflicts between government ministries. On the one hand the Ministry of Health hoped to use premiums to reduce the financial pressures on its health facilities and pay higher salaries. On the other, the Ministry of Agriculture did not want to burden farmers with additional fees. This conflict of interest was exacerbated because many rural health facilities were employing a significant number of largely untrained staff who had begun employment during the Cultural Revolution of the 1970s when training colleges were closed, and they needed to secure funding for their salaries and pensions. Once this group reached retirement age in the 2000s and rural facilities were able to recruit graduates of newly established medical colleges, there was a higher possibility that increased funding would provide benefits to rural residents. In addition, there was no clear agreement on the relative roles of different levels of government in financing health services. The limited local capacity of collecting fees and the low priority in the national reform agenda also contributed to the failed CMS rebuilding in the 1990s [50].

As public health care facilities and workers increasingly operated in a market, the strong, centralized, and hierarchical health care administrative system played an important role in maintaining system resilience. However, as the former Rural Health Bureau Director Li Changming said *"The adaptive behavior of the public healthcare*

facilities and the health care workers under a market economy became increasingly difficult for the Ministry of Health to control".

There were two co-evolving patterns in the transition and adaption process: one was the health facilities and health workers who were becoming increasingly sophisticated participants in the health market often with support from the Ministry of Health; and the second was the efforts by the same ministry to maintain the basic health provision system. As one key informant Li Changming said during our interview *"we are health professionals and health officials, we had to make the health facilities function to serve the people"*.

Second transition and adaptation: implementing the un-implementable through an experimentation process

The limited government funding of health care facilities led them to become increasingly reliant on charges to patients. Rural residents had to pay for treatment and medicines themselves, frequently resulting in impoverishment and/or foregoing of necessary treatment. This was generating pressure on the government to act.

The 2000 WHO report *"Health Systems: Improving Performance"*, ranking the fairness of financial contribution to health systems, ranked China at 188. *"This was considered a loss of face by top leaders"*, said by the former Health Minister Zhang Wenkang. In addition, *"the top leaders were shocked by the rural health conditions and the impoverishment of rural health care"* in China and decided to reform the rural health care system in 2002 and 2003. This was in the context of a change in the country's political leaders and a shift in broad development policy in favor of taking active measures to ensure that all social groups benefited from China's rapid economic development.

Faced with the difficulty of simultaneously modifying multiple components of the health system, the government decided on the development of NCMS as an entry point for reform. The new system was named New CMS (NCMS) in reference to the widely held view that the CMS had been an important achievement of health system development during the 1970s. Further, *"the many efforts to re-establish a social health financing scheme in rural areas during the 1990s provided very useful lessons for policy makers"*, Fu Wei, the NCSM office director said.

The landmark policy *"Decision on Further Strengthening the Public Health Work in Rural Areas"* was issued jointly by the Central Committee of the Communist Party of China and the State Council on October 19, 2002 [51]. The "Decision" made clear that rural China would establish NCMS, and the NCMS would be co-financed by the central and local governments and contributions from individuals. Central government would

contribute 10 RMB, provincial and county governments were required to contribute 10 RMB, and individuals' premiums were set as 10 RMB. The NCMS was designed to cover expenses from catastrophic illness and to be managed at county level instead of village and township levels.

The basics for developing a functional health system

Several factors came together to provide a window of opportunity for the rapid development of NCMS. The Chinese government had made a political decision to alter its development strategy to ensure that all social groups benefited from economic growth. One aspect of this political change was a decision to make fiscal transfers to poor rural counties to support improvements in the provision of services. This was a major change in the management of public finance. The government was looking for "quick wins" to demonstrate its seriousness in meeting the needs of the rural poor.

Meanwhile, the Ministry of Health had supported a number of experiments with CMS, an organizational arrangement that would enable local governments to reimburse people for health costs they had incurred. A number of experienced experts were available to support the development of a national scheme. As a result, a mechanism was ready for translating the new government priority into practice. The government began by transferring very small amounts of money on a matching fund basis to CMS schemes, which reimbursed patients. These schemes were found to be effective in managing the money. Since the government wanted to transfer larger amounts of money, the existence of this mechanism enabled it to earmark the money for health on a matching funds basis. NCMS provided a functioning mechanism to transfer relatively large amounts of money with the confidence that a substantial proportion of the money would be paid to rural people as reimbursement for health care. *"This was an effective mechanism to ensure large numbers of people had visible benefits from this high profile government health program,"* Fu Wei said.

Crucially, in the early 2000s, medical facilities existed in rural areas all over China. Many had benefited from large government programs of investment in physical infrastructure, including health facilities. Also the hierarchical health management system was capable of negotiating with line ministries and local governments, providing a basis for the development of a functioning rural health system, indicated by the key informants at national and local levels.

One key aspect of the early phases of policy implementation was that pilot counties demonstrated a capacity to transfer money into a NCMS fund and to ensure that it was used to reimburse patients. The Ministry of Health put a lot of effort into creating an effective system for managing these flows of public funds

[49]. In doing so, it demonstrated the possibility of subsidizing services used by residents of relatively poor areas [49,52].

Experimentation with incentives

With limited and variable capacity in county health administrations charged with implementing the NCMS, a lack of local-level data on burden of disease and health service utilization, and reliance on a huge number of implementing units, China adopted a experimentation process to allow local governments to adapt the scheme to local conditions and produce lessons that could contribute to scheme design and promote bottom-up learning in development of a central government policy [53,54].

As with many Chinese policies, the central government set the parameters within which sub-national governments should work. Pilots were carried out in approximately 300 counties between 2003 and 2005. Many key elements of scheme design were left to local governments, including amounts of funding, insurance coverage, and design of reimbursement plans, and the management of funding and services. Expert teams were convened to help guide county-level pilots, develop training materials on NCMS design, and carry out training for local government officials and NCMS managers. In 2006, a large-scale interim evaluation of the scheme was carried out. This helped inform subsequent policy and promote convergence in policy design [54]. It was negotiated in the decision making period between government agencies, but once it was implemented, it became very simple as it was primarily the health ministry's job, which injected money into the system and the Ministry of Health and health facilities started to build the provision again. As Fu Wei said, *"when funding is available, everyone is satisfied and the incentive remains strong"*.

Expanding development investment to other components of the health system

Development of other parts of the rural health system, such as the management of medical facilities, drug procurement, establishment of Monitoring and Evaluation systems, and strengthening capacity in rural hospitals and clinics, came after the launch of the health insurance scheme. It is worth mentioning that in the entire process of NCMS development, the Ministry of Health made significant efforts to negotiate with the Ministry of Finance and the National Development and Reform Commission (NDRC), which are in charge of health facility investment to invest heavily in public health, township clinics, and village health stations, as well as county hospitals. The Ministry of Health also issued a series of policies to manage and improve the rural health workforce. The information system is also prioritized in the process of development [52].

Changing the rules of the game and the compromise of system goals

The NCMS was initially a win-win for health facilities/health workers and the general population. Rural residents received tangible amounts of money as reimbursement for medical care. Health facilities generated income from the additional demand for services. Poor counties received a substantial amount of national and provincial money which more than matched their contribution. Over time, the facilities adapted to increase their share of resources. Further, there was competition between different facility levels, so each tried to benefit. Inevitably, this led to cost increases. The government responded with efforts to reform the health system and to ensure that a substantial share of the benefits went to the general public. However, it ran into major stakeholder interests, although the NCMS reform changed the rules of the game by providing substantial amounts of public finance and asking providers to think about the system goals^a.

The evaluation of the NCMS came with the conclusion that the reform had achieved some success in financial protection of the catastrophic health care expenses, and the reform was retained [55-57]. The government rapidly increased the amount of money it contributed to these schemes.

Third transition and adaption: rural health system under the National Healthcare Reform Agenda

In 2009, China embarked on an ambitious healthcare reform, with the goal of providing affordable and equitable basic health care for all by 2020, through universal health insurance coverage, establishing an essential drugs system, improving the primary health care delivery system, managing referrals to special care and hospitals, expanding public health services, and reforming public hospitals [58]. The rural health care reform decision body was located in the NDRC with the Ministry of Health^b as a member. Reform and management of the rural health system became a part of the national health care reform agenda. NCMS-led rural health system development faced a complex management and policy environment. Nowadays, the county hospitals are public but the investment decisions, financial power, and personnel managements are dispersed between many line ministries. The Ministry of Health and the NDRC are responsible for investment; the Ministry of Health, the Ministry of Finance, the Ministry of Human Resources and Social Security, and the Ministry of Civil Affairs are responsible for financial power; the Ministry of Health, the Ministry of Human Resources and Social Security, and the Party's Organizational Department are in charge of personnel management [56].

After three years' of reform effort the complexity of the change process has become increasingly clear. The government introduced an essential drugs policy to

control costs and this was met with strong resistance from the doctors and the health care facilities [41]; the reform of county hospitals faced big challenges [59], and the implementation of reform is now understood to be a complex and challenging process [56]. While outside forces were exerting pressure on the delivery system (through financing system-payment reforms, through reforms in public county hospitals, through drug selling controls, through the creation of a competitive health providers' game, etc.), agents actively adapted to each change in the rules to protect their interests. There is also intense stakeholder lobbying concerning any changes in the roles. For example, the Ministry of Finance has had difficulty in pushing through a reform agenda to lower costs, increase access to quality care when the health system stakeholders are adamant to protect their own interests^c.

Because the national health care reform has been slow to show signs of success, the 2012 National Economic Conference did not include health care reform in its priority list [60]. In March 2013, the National Healthcare Reform Office was relocated to the newly formed National Health and Family Planning Commission. This has been taken by some analysts to be a sign that the health care reform agenda has less priority than before [61]. The third transition and adaption process is far from complete.

Discussion

The case of NCMS provides useful insights into health system development in low- and middle-income countries. Each transition was triggered by a change in the national development agenda. When the macro-policy environment changed, its influence on the health system could be negative (the case of CMS collapse) or positive (the establishment of NCMS). Keeping the health agenda high in the development core agenda is essential to ensure that forced transitions result in beneficial health system development.

China's rural health system has shown great resilience when facing outside forces because it has a strong, centralized, and hierarchical administrative system and the healthcare facilities are publicly owned. The Ministry of Health played a strong advocacy role in pushing for investment in facilities. It also promoted experimentation with an effective mechanism for managing fiscal transfer earmarked for health. The existence of a strong Ministry of Health has been an important force for resilience.

The Ministry of Health has had to balance its responsibilities for meeting national health system objectives with its role as an advocate for the interests of health service providers. It adopted various approaches to cope with the impact of the market economic reform by allowing health care workers and organizations to charge

service fees without fully understanding the long-term impact of the emerging agent behavior on the system goals. These emergent behaviors created policy resistance or mal-adaption when the goal oriented new reform policies were introduced. In some cases, public ownership of hospitals and clinics has reinforced the behavior of agents as they use their position to reduce competition from private providers. This kind of interest group behavior could put the system at risk if it cannot deliver the expected performance to the public and to the government.

The third insight is the need to adapt implementation of policies to local contexts. China's rural health system development between 2003 and 2008 shows that incentive structure is crucial and the limited and varying sub-national capacity need not be a barrier to developing functioning systems. Capable and motivated local government, health care officials, health organizations, and doctors are important for effective implementation. The national policies must be designed to allow flexible local management to get the implementation process started and, in the process, manage the convergence of the policy design.

Finally, the study suggests that an awareness of CAS concepts for understanding system behavior can provide a useful tool for analyzing the likely response to different policy interventions. The many problems that have arisen with the implementation of the rural health system reform policy illustrate the complex, political nature of the management of this kind of change. In particular, the case study highlights the important role of government in establishing clear health system objectives and in providing overall leadership for the management of system change.

China and many other countries are likely to experience rapid and interconnected changes for many years to come. Their health systems will need to adapt to these changes and to their impact on broad development policies. It will become increasingly important that the government increase its capacity to manage this kind of complex change process in order to create a resilient health system.

Endnotes

^aDiscussions in national health care reform meetings where the chief author is a member.

^bMinistry of Health, renamed National Health and Family Planning Commission since March, 2013.

^cInternal discussions participated by the first author in the national health care reform meetings.

Abbreviations

CAS: Complex adaptive systems; CMS: Cooperative Medical System; NCMS: New cooperative medical scheme; NDRC: National development and reform commission

Competing interests

The authors declare that they have no competing interests

Authors' contribution

Authors' contribution: XZ designed the study, conducted interviews, and drafted the manuscript. GB initiated the study, discussed the methodology and core findings, and edited the final draft. XX conducted the interviews, and reviewed the Chinese literature and policy documents. LC reviewed the statistics of rural health system. XL conducted the literature review in NCMS and SJW conducted literature review on system research. All authors read and approved the final manuscript.

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Advancing the application of systems thinking in health: analysing the contextual and social network factors influencing the use of sustainability indicators in a health system – a comparative study in Nepal and Somaliland

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Abstract

Background: Health systems strengthening is becoming a key component of development agendas for low-income countries worldwide. Systems thinking emphasizes the role of diverse stakeholders in designing solutions to system problems, including sustainability. The objective of this paper is to compare the definition and use of sustainability indicators developed through the Sustainability Analysis Process in two rehabilitation sectors, one in Nepal and one in Somaliland, and analyse the contextual factors (including the characteristics of system stakeholder networks) influencing the use of sustainability data.

Methods: Using the Sustainability Analysis Process, participants collectively clarified the boundaries of their respective systems, defined sustainability, and identified sustainability indicators. Baseline indicator data was gathered, where possible, and then researched again 2 years later. As part of the exercise, system stakeholder networks were mapped at baseline and at the 2-year follow-up. We compared stakeholder networks and interrelationships with baseline and 2-year progress toward self-defined sustainability goals. Using in-depth interviews and observations, additional contextual factors affecting the use of sustainability data were identified.

Results: Differences in the selection of sustainability indicators selected by local stakeholders from Nepal and Somaliland reflected differences in the governance and structure of the present rehabilitation system. At 2 years, differences in the structure of social networks were more marked. In Nepal, the system stakeholder network had become more dense and decentralized. Financial support by an international organization facilitated advancement toward self-identified sustainability goals. In Somaliland, the small, centralised stakeholder network suffered a critical rupture between the system's two main information brokers due to competing priorities and withdrawal of international support to one of these. Progress toward self-defined sustainability was nil.

Conclusions: The structure of the rehabilitation system stakeholder network characteristics in Nepal and Somaliland evolved over time and helped understand the changing nature of relationships between actors and their capacity to work as a system rather than a sum of actors. Creating consensus on a common vision of sustainability requires additional system-level interventions such as identification of and support to stakeholders who promote systems thinking above individual interests.

Keywords: Disability, Health systems, Nepal, Physical rehabilitation, Social network analysis, Somaliland, Sustainability, Systems thinking

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Introduction

Health systems strengthening is becoming a key component of development agendas for low-income countries worldwide. As a means to achieve this, systems thinking provides perspectives on how health systems can be assessed [1], recognizing non-linearity, complexity, heterogeneity, uncertainty, and ambiguity of real-world settings [1-4]. The 2009 Flagship Report from the Alliance for Health Policy and Systems Research proposes “Ten Steps to Systems Thinking”, emphasizing the roles of diverse stakeholders in designing solutions to system problems, including sustainability [1]. Studying information flow mechanisms between actors and within networks can help us to understand decision-making processes, as well as the social processes which influence the resilience of socio-ecological systems (including health systems). Asch [5] showed that individuals’ decisions in an unpredictable world are often based on peers’ opinions and actions. Interactions and collaboration between stakeholders depend on various social factors, such as trust, conflict resolution, and knowledge integration [6], and also on circulation of information within social networks [7,8].

The structure of social networks influence individual actors’ capacity to respond to the needs of the system as a whole [9,10]. It follows that understanding system stakeholder networks may be important when analysing how information on system sustainability can be used by the actors of the system to make informed decisions [11,12]. However, the structure of social networks may only be one amongst other factors contributing to the use of data in decisions. Understanding the dynamics of systems therefore requires combining several methodologies to capture the complexity of health programmes, the embeddedness of systems within other systems, and the multi-layered governance of health systems [13-15].

In this paper, we build on previous work to introduce systems thinking among local stakeholders of the physical rehabilitation system in Nepal and Somaliland [16]. Although sustainability has been at the heart of recent international health programmes and policies, the meaning of sustainability remains unclear and confusing to most public health professionals [17,18]. The current challenges for policy-makers and researchers are to translate the concept of sustainability into concrete indicators [19], which will help policy makers and health service managers make public health and management decisions [20]. However, in order to be successful, such a process should also attend to the political tensions involved in “knowledge production” and “norm creation” inherent to sustainability planning in any system. We used the Sustainability Analysis Process (SAP), a system-oriented tool, which encourages participants to arrive at consensus about system boundaries, define sustainability, and identify measurable indicators for a sustainable system [21].

During this process, the concept of sustainability is upheld as normative [22]. The process also avoids decisions taken by a limited number of “experts”. This implies that those participating in the consensus building process are not only acting in their technical expert capacity, but also as “political actors” taking normative decisions on what aspects to uphold [23-26]. Involving a wide range of diverse actors of the health system, including users, of course raises practical problems. For example, the imbalance of power existing between different groups of stakeholders [27,28] means that some topics can be neglected during this process because people who defend them do not receive enough consideration within the group [29-31]. The final “step” of the process additionally includes piloting and re-visiting the measurement of sustainability indicators to judge their fit outside of a workshop setting. The consensus building process needs to capture the tensions between “knowledge production” and “norm creation” in a particular context.

Along with convening and observing sustainability analysis workshops in each setting, we sought to analyse the contextual factors and the characteristics of the social networks to identify the influences affecting actors’ decisions about using sustainability data or not [32,33].

The objective of this paper is to compare the definition and use of sustainability indicators developed through the SAP in two rehabilitation sectors, one in Nepal and one in Somaliland, and analyse the contextual factors (including the characteristics of system stakeholder networks) influencing the use of sustainability data.

Methodology

In order to capture social phenomena such as management decisions and interactions between individuals, an in-depth qualitative research approach was adopted. According to Fitzpatrick and Boulton ([34] p. 107), qualitative research “*is used where it is important to understand the meaning and interpretation of human social arrangements such as hospitals, clinics, forms of management or decision making*”. In real-life contexts, multiple case study designs are known to be appropriate for understanding and interpreting complex causal links in natural setting interventions [35,36]. We combined three different methods; we used stakeholder network analysis, and the SAP at baseline (2010) and at a 2-year follow-up (2012). Interviews with key informants lent depth to the observations, the analysis and helped understand the relationship between the structure of the network, the contextual factors, and the use (or not) of sustainability indicators. Each of these three methods is described below.

Stakeholder network analysis

Stakeholder network analysis was used to map key stakeholders in the physical rehabilitation system and identify

network characteristics. The analysis was conducted in both Nepal and Somaliland in 2010 and again in 2012, and is detailed elsewhere [37,38]. In summary, stakeholder network analysis consists of three stages: (i) describing the set of stakeholders in the network/system (using interviews with stakeholders and document review), (ii) characterising the relationships between stakeholders (interviews), and (iii) analysing the structure of the network/system (using software, see below) [38]. Stakeholders were defined as persons, informal groups of people, or formal organisations who may influence the sustainability of the system through their interactions and individual or collective actions [39-41]. Relationships between actors can be of different kinds and depend on various social factors such as trust, conflict, or knowledge sharing [42]. However, all these social factors are interdependent with one key process: the circulation of information between and within social networks [43,44]. The second stage of stakeholder network analysis consisted of identifying the existence of flows of information between actors or, in other words, the demand (receiving information) and supply (providing information) of information between individuals. This information was collected through interviews. Data collected through interviews were recorded in an information flow matrix: one matrix on the demand for information and a second one on the supply of information. Each respondent thus generated a row of “ones” and “zeros” for each of the two network relations (demand and supply of information): “one” symbolising the existence of demand/supply of information and “zero” signifying no information flow between the two actors. The final matrix was then analysed with the software UCINET to generate statistics about the network structure (Table 1) [39,45], to visually represent relationships within the network and to identify network brokers, who control the flow of information and/or resources within the network [46].

Sustainability analysis process (SAP)

The SAP is a participatory method based on systems thinking, which combines the Process Analysis Method five-step approach [47,48] with a conceptual framework,

the Sustainability Framework, which was applied and tested in international health [49,50]. The five components of the Sustainability Framework, which were used in our study, are: health outcomes, service delivery, organisational capacity and viability, community capacity and context [50]. The SAP also involves five steps, as follows: i) Establish a common understanding of the rehabilitation system in the local context; ii) Define system boundaries; iii) Develop a common vision of sustainability; iv) Select measurable sustainability indicators for the local system; v) Collect baseline indicator data [21,51].

In both Nepal and Somaliland, the SAP method was implemented during a three-day workshop sponsored by Handicap International in 2010 with key stakeholders involved in the physical rehabilitation system. Participants were purposively selected by Handicap International and Naspir, the national federation of rehabilitation providers in Nepal, and by the two national rehabilitation providers in Somaliland. The first list of participants was shared with and reviewed by the two investigators (KB and JP) in relation with the diversity within the rehabilitation sector. The participants included representatives from the Ministry of Health and/or Ministry of Social Affairs, regional health authorities, selected rehabilitation professional staff (physical therapists and orthopaedic technicians), rehabilitation centre managers, representatives of disabled people’s organizations, and representatives of international donors and non-governmental organizations (NGOs) involved locally.

Two-year follow-up workshops were held in both countries in 2012. All the organisations that were represented at the first workshop were represented at the follow-up workshop. After the SAP was reviewed, workshop participants discussed key events that influenced the sustainability of the rehabilitation sector during the intervening 2 years. Sustainability indicators were re-measured, where possible, and participants reflected on progress toward self-defined sustainability goals.

In-depth interviews and observations

Analytic narrative was used to provide explanations of unique events and outcomes, and can serve the interests of the social researchers who try to describe what events take place, why, as well as their significance to actors within a system [52]. Analytic narrative is considered “a useful tool for assessing causality in situations where temporal sequencing, particular events, and path dependence must be taken into account” ([53] p. 1,164). The analytic narrative approach consists of interviewing key actors and understanding their goals, and the main factors influencing their behaviour and decisions [52]. It also requires analysis of the interactions between actors and their impact on institutional settings: “The emphasis is on identifying the reasons for the shift from an institutional

Table 1 Definitions of key network characteristics measured

Characteristic	Definition
Betweenness	Indicator of centrality of the network as a whole [39]. Corresponds to the number of direct ties a stakeholder has with any other actor compared to the total number of direct ties [39]. The higher the percentage of betweenness, the more centralised the network.
Density	Indicator of network cohesiveness [39]. Defined as the number of existing ties divided by the number of possible ties between stakeholders. Reported on a scale ranging from 0 (no ties at all) to 1 (all actors are connected to all others).

equilibrium at one point in time to a different institutional equilibrium at a different point in time" ([54], p. 11).

Information was collected from key informants on experiences with collecting and analysing sustainability information by individual actors/organisations. Interviews were conducted in private and participants were assured of confidentiality to encourage participants to share potentially sensitive issues and insights. Interviews were recorded. Transcripts and notes from each interview and group discussion were read in their entirety before coding line-by-line to identify and label ideas and meanings conveyed in each small section of text. These codes were then grouped and labelled to reflect broader themes within the data. Further additions and revisions to the coding framework were made on a continual basis as higher level constructs were generated, through reviewing emerging themes and interpreting them in relation to stakeholder network analysis findings.

Results

The 2010 (baseline) physical rehabilitation stakeholder networks in Nepal and Somaliland

The structure and properties of the physical rehabilitation stakeholder networks in Nepal and Somaliland are described and compared elsewhere [16]. Key notions are summarised as follows.

In 2010, the social network of rehabilitation actors in Nepal (56 actors) was over twice as large as the network in Somaliland (22 actors) and there were substantial differences in the types of actors involved in service delivery and system governance. Notably, in Nepal, three ministries – the Ministry of Health and Population, the Ministry of Women, Children and Social Welfare, and the Ministry of Peace and Reconstruction – were directly involved in governance of physical rehabilitation services. In Somaliland, the Ministry of Public Health was solely in charge of rehabilitation services, although the Ministry of Labour and Social Affairs coordinated broader disability issues.

Country differences in the involvement of local NGOs and disabled people's organisations were also marked. In Nepal, local organisations provided services and directly managed rehabilitation centres. These organisations included professional associations (Nepal Physical Therapy Association and Prosthetist and Orthotist Society of Nepal) and disabled people's organisations. In Somaliland, a much narrower range of actors delivered rehabilitation services. Specifically, two non-profit rehabilitation organisations (Disability Action Network (DAN), supported by Handicap International and the Somaliland Red Crescent Society (SRCS), supported by the International Red Cross Movement) were responsible for the entirety of rehabilitation service delivery. Both organisations in Somaliland were based in the capital city with complementary networks of

partners and providers in the periphery. Disabled people's organisations were not involved in service delivery, nor did they play a role in advocating for rehabilitation resources.

In 2010, Somaliland's system stakeholder network was four times more centralised than in Nepal. Nepal's network density was twice as great as in Somaliland (0.2 in Nepal compared to 0.1 in Somaliland) (Figures 1 and 2). The density of a network is the proportion of all possible ties between actors that are actually present. A centralised stakeholder network, such as in Somaliland, is thought to facilitate communication and innovation, as only a limited number of key actors are involved [39,55]. On the other hand, centralized networks can easily generate bottlenecks if any of the key stakeholders (brokers) block diffusion of information and/or resources. In a dense network, such as in Nepal, the circulation of information between actors is also rapid but with a much lower risk of bottlenecks.

The 2010 (baseline) self-defined sustainability indicators in Nepal and Somaliland

Discussions that took place during the 2010 SAP workshops differed between the two countries. A comparison of 10 key self-defined sustainability indicators in each of the two countries is provided in Table 2 (the full list of indicators chosen is available in [56,57]). In Somaliland, discussions about indicators, their measurement, and recommendations for the system focused on the two rehabilitation facilities existing in that country. Being at the centre of the network, the sustainability of these organisations highly affected the sustainability of the overall system. Sources of instability in the system consisted of the lack of long-term financial resources for centres in the capital as well as poor access to service users outside the capital. In Nepal, a number of rehabilitation centres existed, but populations living in remote areas were not reached with the level of resources and investment at that time. Sustainability indicator discussions in Nepal therefore focused largely on mainstreaming physical rehabilitation into priority health and social programs, while also transferring some services to other actors at the community level.

In terms of physical rehabilitation goals, network members in both Somaliland and Nepal focused on increased access to and coverage of rehabilitation services across regions (e.g., percent of people with disabilities by rehabilitation centre whose physical rehabilitation needs have been met). In Somaliland, the rehabilitation providers were concerned about the centralisation of services in the capital and the provinces being underserved due to insecurity outside Hargeisa, the capital, restricting both expansion of service provision and the ability of patients to complete referrals made from the periphery.

In terms of service provision, both stakeholder groups recognized that limited numbers and poor geographic distribution of rehabilitation professionals



Figure 1 The physical rehabilitation stakeholder network of Nepal in 2010 (baseline).

would threaten the sustainability of their system. In Somaliland, network members emphasized the need for professionals to provide services outside the capital city by analysing human resources regionally. In Nepal, stakeholders took a more systemic view and identified the total number of rehabilitation professionals who needed to be trained in the country over the next few years as a sustainability indicator.

In terms of organisational and financial capacity, Somaliland network stakeholders placed strong emphasis on the financial autonomy of rehabilitation service providers (e.g., number of different sources of funding) and team management (e.g., percent of staff with job descriptions or number of coordination meeting per year). One of the two service providers in Somaliland was approaching the end of a funding cycle and had no certainty that international support would continue after the end of 2011. Hence, sustainability indicators specified diverse funding sources and reduced financial risk. Some actors identified the emergence of donors in the domestic and diaspora private sector as an attractive means to diversification, particularly as trust in the political will of the Ministry of Health (a potential influential actor within the network) to intervene in rehabilitation was low.

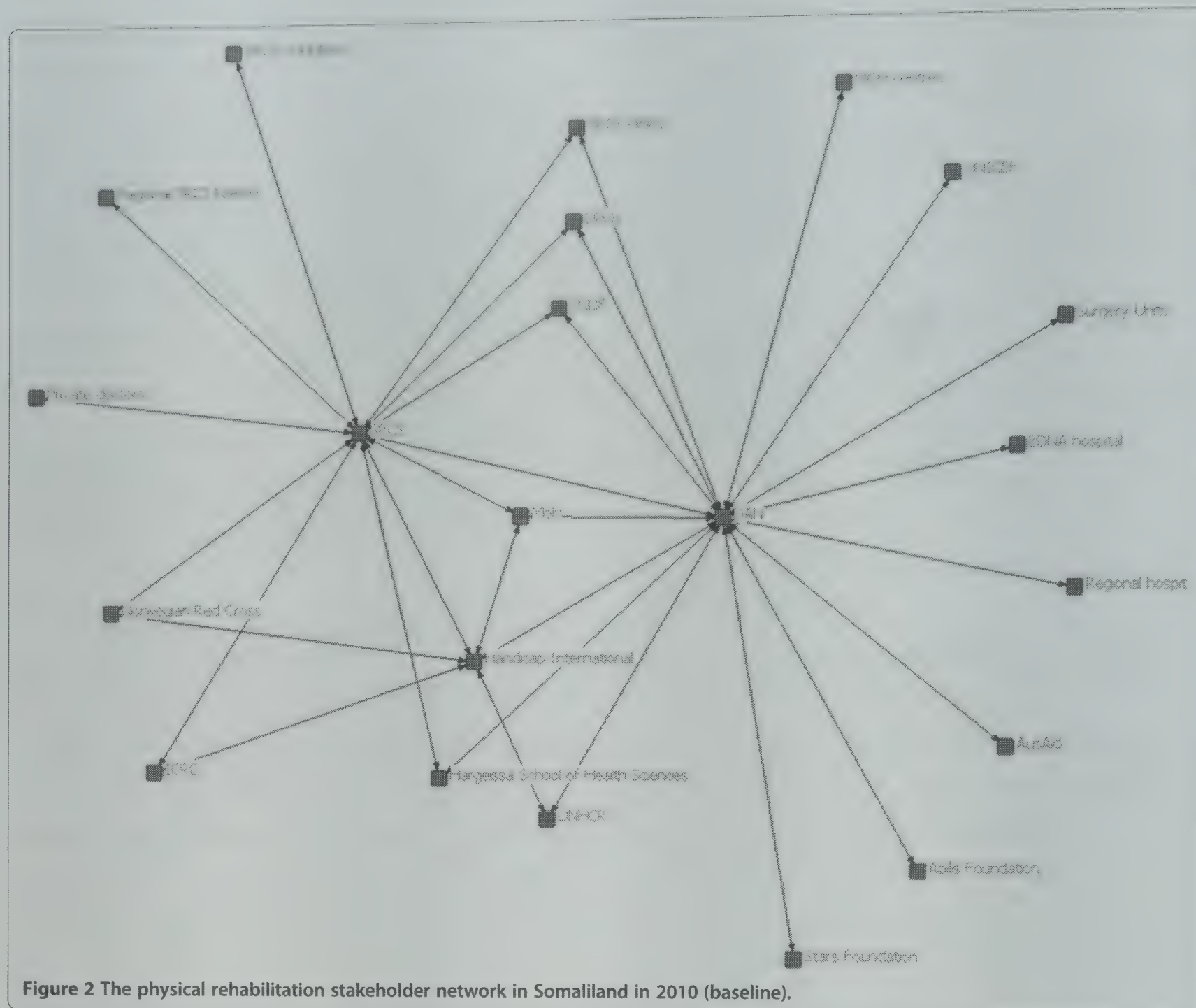
In Nepal, organisational and financial sustainability goals are aimed at integrating physical rehabilitation into national policies and other programmes (e.g., disability integrated into female community health volunteer activities). Mainstreaming physical rehabilitation into other social or health systems represented an opportunity to secure

resources that were not available in an isolated rehabilitation system. Furthermore, network members in Nepal recognised the need to associate with actors outside their system working at the community level to increase coverage of services.

In terms of community capacity, the choice of sustainability indicators in both countries reflected the level of cohesiveness between the rehabilitation services and community-based organisations. In Somaliland, network members defined “community” as the users of the rehabilitation services, and community participation was described in terms of the financial capacity of users to pay for services (e.g., percent of people with disabilities who contributed to the cost of the service) or participation of users in the planning of rehabilitation services (percent of assessment and planning exercises involving community members – i.e., people with disabilities, see full indicator list).

In Nepal, the “community” was defined as the population living in areas served by rehabilitation centres rather than only existing or potential service users per se. Community capacity was perceived as the capacity of community organisations to organise themselves (e.g., percent of disabled people organisations that have action plans) and integrate disability and rehabilitation into their activities at decentralised levels (e.g., percent of districts with District Disability Rehabilitation Committees and Village Disability Rehabilitation Committee, see full indicator list).

In terms of the enabling environment, in both countries, workshop participants recognised the importance of



securing political commitment at the national level to develop and implement disability-related policies (e.g., in Nepal, the existence of a national action plan on rehabilitation) and allocate public financial resources to the rehabilitation sector (e.g., in Somaliland, percent of price covered by Government).

Physical rehabilitation stakeholder networks in Nepal and Somaliland at 2-year follow-up

The system stakeholder network in Nepal became slightly less decentralised but denser over the 2 years from 2010 to 2012 with the appearance of seven new actors (including international and local organisations) (Figure 3).

In Somaliland, the major change was the disappearance of the relationship between the two principle brokers of the network (DAN and SRCS). Between the two SAP workshops, the two service providers never formally met to discuss the management of rehabilitation services or

the governance of the system. The system became divided into two sub-systems with each service provider at the centre and surrounded by collaborative organisations. In spite of this system fracture, in 2012, the stakeholder network remained highly centralised (61%) and low in density (0.1) (Figure 4).

Comparative 2-year sustainability progress and use of self-defined sustainability indicators

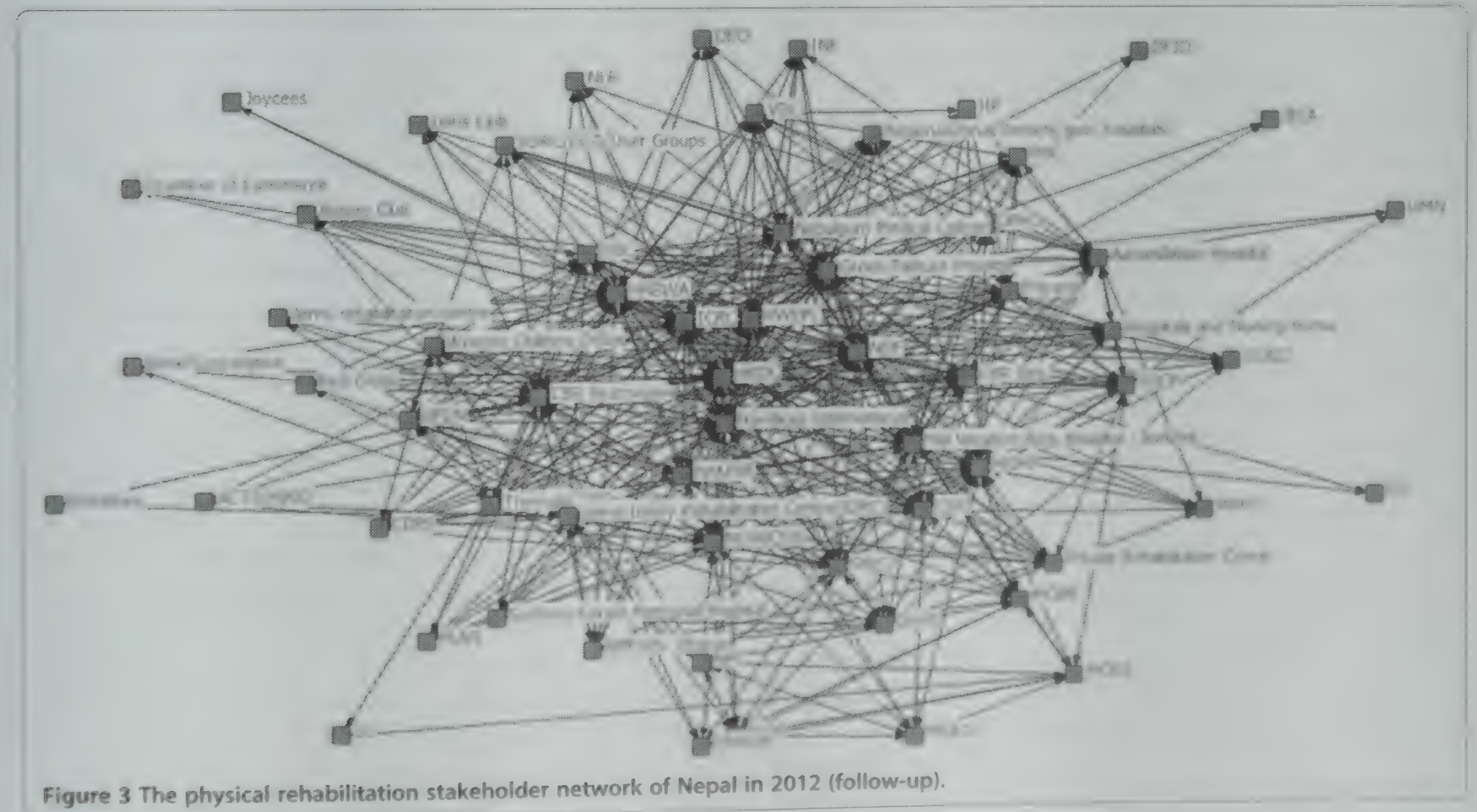
At 2-year follow-up there was little progress towards the local vision of sustainability and almost no use of the self-defined sustainability indicators in Somaliland. System stakeholders individually had not attempted to undertake organisational measurements or use this type of information in decision making, although most still perceived the indicators to reflect their vision of sustainability of the system. During this period, no organisation took the lead to coordinate follow-up of the SAP. Handicap International had sponsored the workshop and was

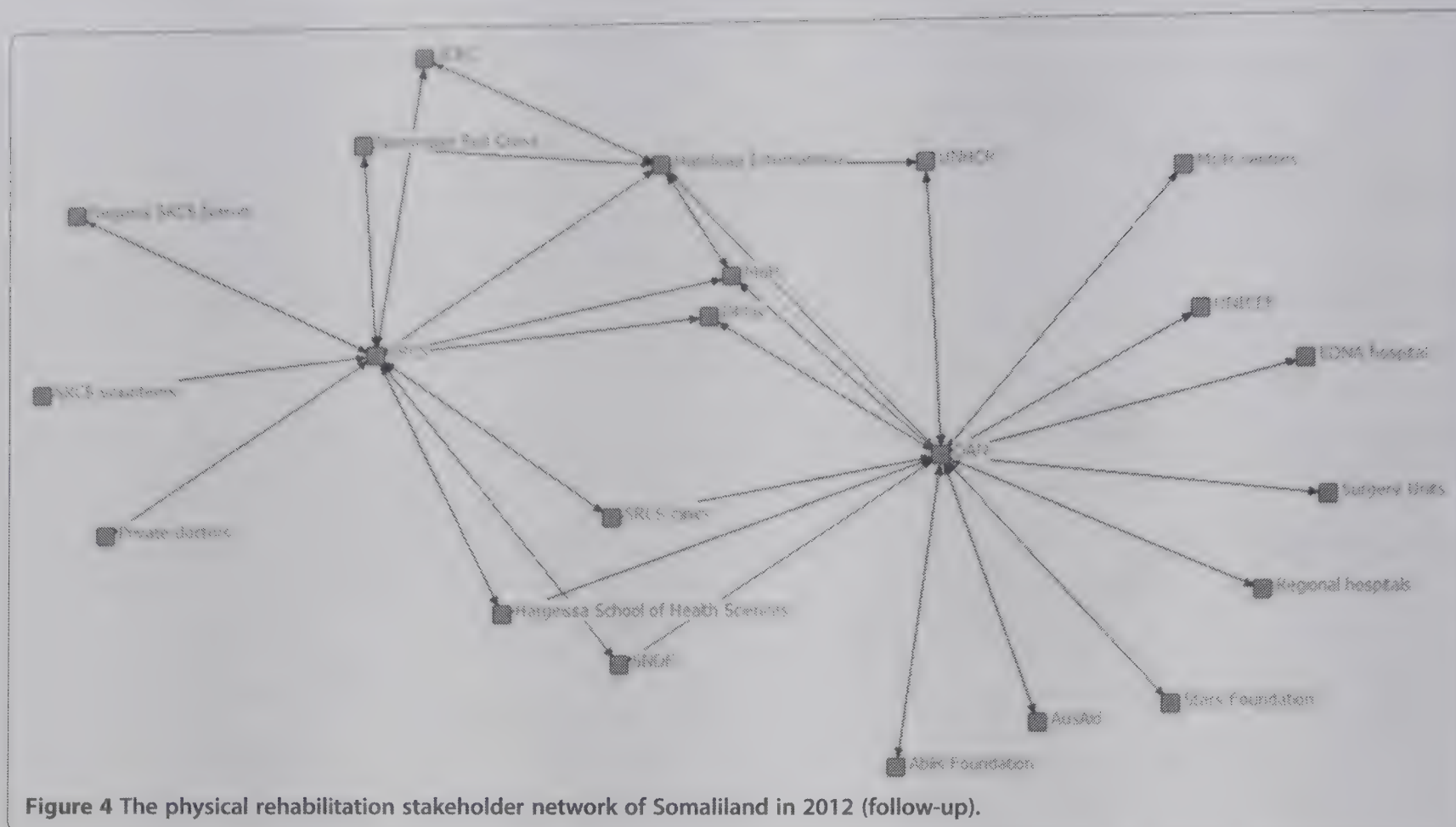
Table 2 Example of 10 key self-defined sustainability indicators for the physical rehabilitation system in Somaliland and Nepal, by sustainability component

Sustainability components	Sustainability indicators	
	Somaliland	Nepal
Rehabilitation outcomes or outputs	Percent of people with disabilities (PWDs) entering the centre and whose needs were fulfilled	Number of treatment sessions delivered per month
	Percent of PWDs who were referred to other services	Number of prostheses and/or theses produced every year
Service provision	Number of physiotherapists and prosthetics and orthotics technicians (P&O) in Somaliland	Percent of centres of who have at least 1 category I P&O
	Percent of regions with at least 2 PT Assistants and 2 P&O Assistants	Number of CAT I P&O who need to be trained by 2015
Organisational and financial capacity	Number of different sources of funding	Percentage of catchment districts referring patients to centres
	Percent of staff with job descriptions	Number of female community health volunteers trained in identification of disabilities
Community capacity	Percent of PWDs and carers who know the existence of rehabilitation centres	Percent of districts with District Disability Rehabilitation Committees and Village Disability Rehabilitation Committee
	Percent of assessment and planning exercises involving service users	Percent of Disabled People Organisations that have action plans
Enabling environment	United Nations Level of Security	Percent of funding allocated by Government to rehabilitation
	Percent of costs covered by Government	Existence of a national action plan on rehabilitation

perceived as the “owner” of the initiative by some actors, who expected the international NGO to continue the lead role. Handicap International, however, was reluctant to maintain active involvement in coordination since their overall objective was to hand-over their support to rehabilitation services to local partners. The Ministry of Public Health had limited capacity and political will to fulfil this role. The two main service providers continued to be

focused on the survival and viability of their own individual organisations. Several system stakeholders characterised sustainability as “unachievable” under current conditions in Somaliland, without sufficient funding and support from the Ministry of Public Health. In Somaliland, by 2012, apart from a tax break on land for rehabilitation facilities, there was still no government funding allocated to provision of physical rehabilitation services.





and information-sharing, appeared to support the advancement of system sustainability in Nepal by encouraging the participation of major stakeholders outside the rehabilitation sector in sustainability initiatives between 2010 and 2012. Following the first workshop and lobbying from the main actors of the network, three Nepalese Ministries (whose representatives had been invited to the final presentation of the sustainability indicators) agreed to invest funds to improve the functioning of the rehabilitation system as a whole instead of targeting specific rehabilitation centres. Their initial idea of creating new rehabilitation centres in the country was changed after the rehabilitation actors presented their vision of the sustainability of the sector. As a result, the Ministries agreed to support existing facilities and initiatives.

In contrast, in Somaliland, systems thinking and action was observed during this period only in an area peripheral to rehabilitation service delivery, on disability mainstreaming initiatives to increase government involvement in wider disability programming in the social sector [58]. This involved extensive collaborative work with actors across the rehabilitation system, under the auspices of the Ministry of Labour and Social Affairs. Partly, motivations for doing this work appeared to be in response to specific funded opportunities through government and international organisation channels. These, however, required a far lesser commitment of financial resources than opportunities for reform of rehabilitation services would have. There was also little evidence to suggest that information created during the SAP was used in these mainstreaming initiatives. While

potentially laying the groundwork for systemic work on physical rehabilitation services in the long term, in the shorter term, over which this study was conducted, we found little evidence of systemic thinking helping to resolve the problems rehabilitation actors described facing to achieve their vision of sustainability in Somaliland.

Discussion

In this study, we compared the selection and use of self-defined sustainability indicators in two countries to analyse the influence of contextual factors and social network structure on the development of physical rehabilitation systems. Our assumption was that baseline differences between the two networks as well as the nature of relationships between actors would influence the way the sustainability indicators would be defined and used during follow-up.

The definition of key sustainability indicators was implicitly influenced by network characteristics and actors' perception of their own system. In Nepal, the stakeholder network at baseline was decentralized and dense with a wide diversity of stakeholder types. Here, vision of the future system was inherently systemic, including concerns about the coverage of services but also how the actors of the system work together and how integration of new actors could increase system impact. The actors of the rehabilitation sector who were interviewed recognised the importance of creating unity between all the actors of the network in order to more effectively negotiate with national authorities and donors. Hence, a national body representative of all the rehabilitation providers (NASPIR) was created in Nepal. In Somaliland, where the stakeholder network was centralized in the capital city and low in density (few stakeholders and brokers), the vision of the future physical rehabilitation system was constructed around the two rehabilitation facilities, positioned at the very centre of the system, and mainly represented their perspective. They focused on the extension of the services towards the provinces.

Social network analysis provides tools to identify knowledge brokers, i.e., individuals who create links between different groups within a system, such as between users and researchers, which was the case of the two rehabilitation centres in Somaliland [45]. The brokers in a health system also help coordinate actors in times of crises or shocks [59]. Other actors essential to the diffusion of innovations, such as opinion leaders, champions, or change agents, can variously be identified through the number of links they have with their peers or non-peer actors at different levels of the health system [60,61]. One assumption from social network analysis is that the position of actors in a network determines their capacity to access and diffuse knowledge and information or, in

other words, control the flow of information [62,63]. A network with a central structure, such as Somaliland's, has more capacity to coordinate actors and provide a rapid response, which may be very important during humanitarian crises [64]. However, in Somaliland, during the 2-year post-conflict period that we observed, the central position of the brokers in this much centralised network blocked the circulation of information and the use of sustainability data. Promising developments within the wider disability social movement in the country may, however, help overcome some of these circulation blocks between brokers in the future if more actors are brought into the network, thereby de-centralising information and decision making in the system.

The use of self-defined sustainability indicators by the system was also influenced by individual actors' survival strategies. At 2-year follow-up, the dense network in Nepal became even stronger as actors prioritised integration of services for organisational growth and survival and was an enabling factor in the utilisation of sustainability indicators [58]. The emergence of a local champion, the sustainability coordinator, who was granted legitimacy by professional organisations and financial support by an international organisation, facilitated communication necessary to continue system sustainability work in Nepal within the rehabilitation sector. On the other hand, in Somaliland, the changing nature of relationships between the two main brokers of the networks completely disrupted the circulation of information between actors due to the highly centralized, low-density structure of the rehabilitation sector. This resulted in no follow-up activities to monitor or use the self-defined indicators. The space and time horizons [11,32], which Somaliland stakeholders used to think about sustainability, shrank dramatically between 2010 and 2012 due to the interruption of international funding in the country. In formal network analysis terms, the "relationship" between the two main actors of the system disappeared in 2012 after they realised that their main and pressing priority was the survival of their own organisations. Midgley [65] showed that the decisions of individuals are primarily influenced by their survival instinct. Even well-documented evidence-based data cannot influence the decisions of an individual if the decision in conformity with the evidence represents a threat to his/her own interests and survival (e.g., professional career, family situation, or life threatening situation) [66]. When brokers shrank their sphere of intervention from the system to an organisation, the centralised stakeholder network in Somaliland, by nature of the relationships between brokers, suffered a bottleneck and therefore a barrier to systems thinking.

As this study demonstrates, adopting a system thinking approach involves at least three elements. First, it is essential to understand the choices and decisions being made by

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individual actors; second, to understand the positions of actors within the system, recognising that the choices of some actors have disproportionate influence on the system as a whole; third, it is important to understand the wider context affecting changes in the system over time (i.e., the existing social networks and the relationships between actors), recognising that systems are dynamic, social entities which are in constant mutation or adaptation [67].

Conclusions

The highly centralised structure of the social network in Somaliland had potential to help rapidly diffuse information between actors, which might be very useful in contexts of emergency (conflict or natural disaster). However, the rupture of relationship between the two central actors of the network completely disrupted the functioning of the rehabilitation sector and lead to the non-use of sustainability data in a sector that became the sum of dispersed actors. In Nepal, the cohesion between actors was maintained thanks to the role of a local champion and the injection of additional funds in the sector. The network remained very dense and decentralised and actors there appear to be gradually building a systemic vision of their sector, which takes account of data such as sustainability indicators for planning and negotiation purposes. These findings suggest that using sustainability indicators for a health system requires cohesion within the system between all (or most) actors, as well as an understanding, by actors, of the benefit of a collective vision for the sector. Contextual factors, such as the availability of funding for activities that primarily benefit the system rather than individual actors or organisations, can also support this. Further research is needed to analyse the different strategies that are required for health system interventions to alter the characteristics of social networks in social contexts for a collective good.

Abbreviations

DAN: Disability Action Network; SAP: Sustainability Analysis Process; SRCs: Somaliland Red Crescent Society.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

KB and JP designed the methodology and the data collection tools. KB, JP, DB, RP, and AJ collected data. JP and KB analysed data. KB drafted the article. JP, SG, and KB reviewed the draft version.

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RESEARCH

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Advancing the application of systems thinking in health: sustainability evaluation as learning and sense-making in a complex urban health system in Northern Bangladesh

Eric G Sarriot^{1*}, Michelle Kouletio², Dr Shamim Jahan³, Izaz Rasul⁴ and AKM Musha⁵

Abstract

Background: Starting in 1999, Concern Worldwide Inc. (Concern) worked with two Bangladeshi municipal health departments to support delivery of maternal and child health preventive services. A mid-term evaluation identified sustainability challenges. Concern relied on systems thinking implicitly to re-prioritize sustainability, but stakeholders also required a method, an explicit set of processes, to guide their decisions and choices during and after the project.

Methods: Concern chose the Sustainability Framework method to generate creative thinking from stakeholders, create a common vision, and monitor progress. The Framework is based on participatory and iterative steps: defining (mapping) the local system and articulating a long-term vision, describing scenarios for achieving the vision, defining the elements of the model, and selecting corresponding indicators, setting and executing an assessment plan,, and repeated stakeholder engagement in analysis and decisions . Formal assessments took place up to 5 years post-project (2009).

Results: Strategic choices for the project were guided by articulating a collective vision for sustainable health, mapping the system of actors required to effect and sustain change, and defining different components of analysis. Municipal authorities oriented health teams toward equity-oriented service delivery efforts, strengthening of the functionality of Ward Health Committees, resource leveraging between municipalities and the Ministry of Health, and mitigation of contextual risks. Regular reference to a vision (and set of metrics (population health, organizational and community capacity) mitigated political factors. Key structures and processes were maintained following elections and political changes. Post-project achievements included the maintenance or improvement 5 years post-project (2009) in 9 of the 11 health indicator gains realized during the project (1999–2004). Some elements of performance and capacity weakened, but reductions in the equity gap achieved during the project were largely maintained post-project.

Conclusions: Sustainability is dynamic and results from local systems processes, which can be strengthened through both implicit and explicit systems thinking steps applied with constancy of purpose.

Keywords: Complex adaptive systems, Equity, Evaluation, Health systems, Learning, Participatory, Prevention, Sustainability, Systems thinking, Urban health

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Background

Whether we understand the social world (including health systems) as operating through systems, or we take systems thinking simply as a useful mental construct to deal with the complexities of our social world [1], there is a growing attention to systems thinking in multiple fields of development practice and research, including global health. In the global development literature, one may argue that this school of thought started with Amartya Sen's book, *Development as Freedom* [2], and Rihani's *Complex Systems: Theory and Development Practice* [3]. Studies and implementation guidelines for 'systems thinking' have been published in journal supplements in 2006 and 2007 [4,5]. The Alliance for Health Policy and Systems Research published *Systems Thinking for Health Systems Strengthening* in 2009 [6], and then supported the publication of a Journal supplement in *Health Policy and Planning* in 2012, dedicated to the applicability of systems thinking tools for health systems strengthening [7]. Over the same period (2008 to 2010), different authors have used case studies to describe how complexity and adaptation play a central part in capacity building [8-10]. Overlapping with the field of global health and global development, the world of evaluation is itself trying to better approach non-linear realities, complexity, and systems thinking [11]. Williams [12] presents 11 evaluation case studies reporting the use of systems methods and concepts to evaluation, and Patton [13] writes and teaches on Developmental Evaluation, a methodology explicitly anchored in an understanding of the world as composed of overlapping open systems. Discussions, research, and evaluation on sustainability in health programs appear to have followed a similar evolution (see "A systems understanding of sustainability" below). Over the same decade and a half, a group of practitioners, working in community health at local levels and globally, followed an interesting if not identical intellectual trajectory, when dealing with the specific issue of improving the sustainability of their interventions. Non-Governmental Organizations (NGOs) working globally in maternal, reproductive, and child health formed the Child Survival Collaborations and Resources Group in 1997 (now known as the CORE Group^a). In 2000, CORE partnered with a US Agency for International Development (USAID) project implemented by Macro International in a study called the 'Sustainability Initiative', in order to improve the conceptualization and implementation of more sustainable strategies in community health [14,15]. By 2002, this collaboration had produced a tool (the Sustainability Framework) for sustainability planning and evaluation. By this time, Concern Worldwide Inc. (Concern) had been implementing an urban health project in two Municipalities of Northern Bangladesh since 1999. Concern's interest in capacity building and sustainability led to a time of critical

questioning at the time of its mid-term evaluation in 2002, 2 years before the end of the project [16]. Concern needed an evaluation and learning tool able to guide the implementation of project strategies (by the municipalities themselves) toward greater odds of sustainability. The interest in learning, however, bridged the local Bangladeshi and the global context when USAID provided additional funds to Concern to carry out a post-project evaluation 3 and 5 years after the end of the project (2007 and 2009).

A systems understanding of sustainability

Conceptual and methodological debates about sustainability continue in the literature [17,18], but the identification of complex systems behaviors as fundamental determinants of sustainability, which was already identified to some extent by a number of past authors [19-21], has become more explicit in recent publications [3,9,22-25].

Under the Sustainability Framework, sustainability is seen as resulting from processes taking place in a local system where a wide array of stakeholders share responsibility to generate and maintain positive health outcomes for their community, inclusive of its most vulnerable groups. It offers an interactive model for assessing progress on critical dimensions [26], such as the health outcomes being promoted, characteristics of health services (quality, accessibility, equity), institutional capacity and viability of local government and civil society agencies with long-term responsibility for the outcomes, capacity in beneficiary communities (e.g., social capital, community organization, knowledge/skills, resource mobilization), and socio-ecological conditions enabling the work of these local agents.

This paper presents how Concern adapted and used a systems approach to place sustainability at the front end of project implementation and learning, to build consensus, find common values, use data for learning and adaptive management, and assess progress toward sustainability, during and after the life of the project.

Urban health in Bangladesh and Concern's urban health model in Saidpur and Parbatipur (1999-2004)

Bangladesh is a low-income country with poor health indicators. Its under-five mortality decreased rapidly in the 1990s, then slower in the 2000s [27,28]. The infant mortality rate decreased from 72/1,000 live births in 2004 to 57/1,000 in 2007 according to the Demographic and Health Survey [29]. The fastest growing sector of the population lives in urban areas and a third of those, in urban slums. The urban population grew from 23% of the total population in 2001 [30] to 28% by 2010 [31]. This population is largely vulnerable, impoverished, malnourished, and receives poor health care services [32].

Municipalities are legally tasked with ensuring the delivery of primary health care services to the population

but had developed almost no capacity to do so at the onset of Concern's project. For instance, due to limited resources, public-sector health services were not able to meet the existing needs in 1999. Private health care providers were the main source of curative care, including tertiary and specialized services to the urban populations, but had limited or no interest in providing preventative and health promotion services.

In 1995, the Ministry of Local Government, Rural Development and Cooperatives issued a directive for the effective implementation of expanded programs on immunizations, along with primary health care and family planning services through a coordinated effort involving the Ministry of Health and Family Welfare, NGOs, and private providers. Committees were recommended, although not established, at three different levels to ensure effective health service delivery: inter-ministerial committees, central committees at municipal levels, and Ward Health Committees (WHCs) at the community level.

Concern initiated a USAID-funded child survival project in the municipalities of Saidpur and Parbatipur in Nilphamari and Dinajpur districts in 1998, with full implementation from 1999 to 2004. The two municipalities had a direct beneficiary population of 74,000 women of reproductive age and children under 5. Concern selected what, at the time, was a non-traditional capacity building approach, based on a partnership with the two mayor's office and their under-resourced municipal health departments (MHDs) [33]. Concern supported the organizational

development of the municipality cabinets and through them developed the capacity of WHCs at the community level. In turn, and collaboratively with the MHDs, the WHCs recruited, trained and supported a network of community health volunteers (CHVs) and traditional birth attendants, who carried out community and household-level health promotional activities.

Two years into the project, the results of the mid-term evaluation were very promising but pointed out to the lack of measurable results and signaled important sustainability challenges. Concern's strategic response to the mid-term evaluation implicitly relied on systems thinking (Table 1). The project, however, also needed a method, an explicit set of processes, to guide a diversity of stakeholders in the pursuit of sustainable health goals. Concern chose the Sustainability Framework as the tool through which it could organize the creative thinking of multiple stakeholders, create a common end-goal, and monitor progress on its redesigned sustainability strategy.

HICAP, Health Institution Capacity Assessment; MHD, Municipality Health Departments; MOH, Ministry of Health; WHC, Ward Health Committee; MOHFW: Ministry of Health and Family Welfare is the same as MOH and was removed.

We now describe how the Sustainability Framework method was implemented following the mid-term evaluation (2002), up through the final evaluation (2004) [34], all the way to the 5-year post-project sustainability evaluation in 2009. The steps of implementation, sustainability

Table 1 Implicit and explicit operationalization of systems thinking for Concern, Saidpur and Parbatipur

Principle in systems thinking ^a	Concern's management decision (implicit system approach)	Sustainability Framework (explicit method)
Consider boundaries of system, nested and overlapping systems	<ul style="list-style-type: none">• Making the distinction between the national health system and local urban administrative systems, and focusing capacity building on the MHDs	<ul style="list-style-type: none">• Local system and stakeholder mapping• Identification of interrelated roles between MOHFW and MHD
Construct reality through multiple perspectives	<ul style="list-style-type: none">• Voices from all segments of society included in process• Participatory process	<ul style="list-style-type: none">• Visioning and scenario planning• Iterative, evidence based, and• participatory review of progress• Gender and equity awareness building through diversity in planning
Value and build on relationships	<ul style="list-style-type: none">• Forum creation for relation between MHD – WHC – MOH• WHC as a hub for health promotion• Accountability of the municipal government to communities	<ul style="list-style-type: none">• Participatory assessment, bringing diverse stakeholders together• Mutual accountability through review of progress
Iterative learning	<ul style="list-style-type: none">• Defining assessment criteria in HICAP and WHC• Involvement of MHD and WHCs in Knowledge, Practice and Coverage Household Health Surveys including disaggregation by wealth quintiles to assess equity	<ul style="list-style-type: none">• Regular measurement of outcomes in multiple dimensions of assessment• Cycle of visioning, defining measures, measuring, reviewing, adjusting

^aThere is not one set of recognized systems thinking principles, and this table is not exhaustive. Williams [12] emphasizes boundaries, perspectives, and relationships as central to systems thinking. Many authors emphasize learning, and specifically iterative learning, as an essential principle. Other authors also stress the value of collaboration across disciplines, sectors and organizations, transformational leadership, alternative scenario planning, using diversity of stakeholders to brainstorm and design, etc. [6,7,26].

planning, project evaluation, and post-project sustainability evaluation are summarized in Figure 1.

Methods

The sustainability assessment is an iterative exercise designed for intervention design, evaluation, and continued learning. It requires the definition and planning of a multi-dimensional evaluation model and its major components, based on the Sustainability Framework (see “Defining sustainability for health interventions in global development” below), and measurement steps through field investigations, which took place through ongoing project monitoring and evaluation until 2004, and after the project’s end.

Defining sustainability for health interventions in global development

We define sustainability as resulting from a collective process within a local system, which maintains or improves the health status, or a sub-set of health outcome indicators, of the locale’s citizens, particularly its most vulnerable members.

Individuals, community groups and structures, and government and civil society organizations constitute a local system within a larger environment, and it is ultimately their coordinated social interactions and efforts, based on the understanding of their own health and development, which will lead to lasting health conditions.

The loss of control over local processes beyond a set date is inherent in project approaches. This means that the immediate determinants of sustainability are based on a local process of negotiation, role definition, and action, and are effectively outside the full control of a time-bound project. Projects, nonetheless, have an essential responsibility in advancing the key determining conditions for sustaining outcomes within the local system.

The value of the Sustainability Framework relies heavily on the quality of its contextual development and implementation process. The method is described elsewhere as a participatory process involving the six steps described in Figure 2, bringing together situation assessment, planning, evaluation, and strengthening relationships between the actors, based on consistent reference to data and learning steps [23].

We describe now how these steps were adapted by Concern and which elements of planning and evaluation were integrated in the model:

- 1) *Defining (mapping) the local system, and the common long-term vision*

In February 2003, Concern and its partners defined the system of local actors expected to carry out the task of health promotion at the municipality level during a 6-day workshop using stakeholder mapping, and developing a common vision through participatory group activities [14]. This initial workshop involved Concern project team members, 15 municipality staff nominated by the municipalities, and Concern capacity building and child survival advisors. All work was conducted in Bangla in small groups. Final statements were finalized in plenary and presented to municipal and ward institution leaders. This provided a safe environment for the development of a shared vision and discussion of contextual challenges. The central constituents of the system that was mapped were Mayors, elected Councilors, and the MHDs in the leadership role; WHCs as an expression of the communities, working through CHVs, and local health care providers, such as a local hospital and NGO clinics. This system definition encouraged a broader inclusion of WHC members (not just leaders) and CHV representatives in future exercises (2004, 2007, and 2009).

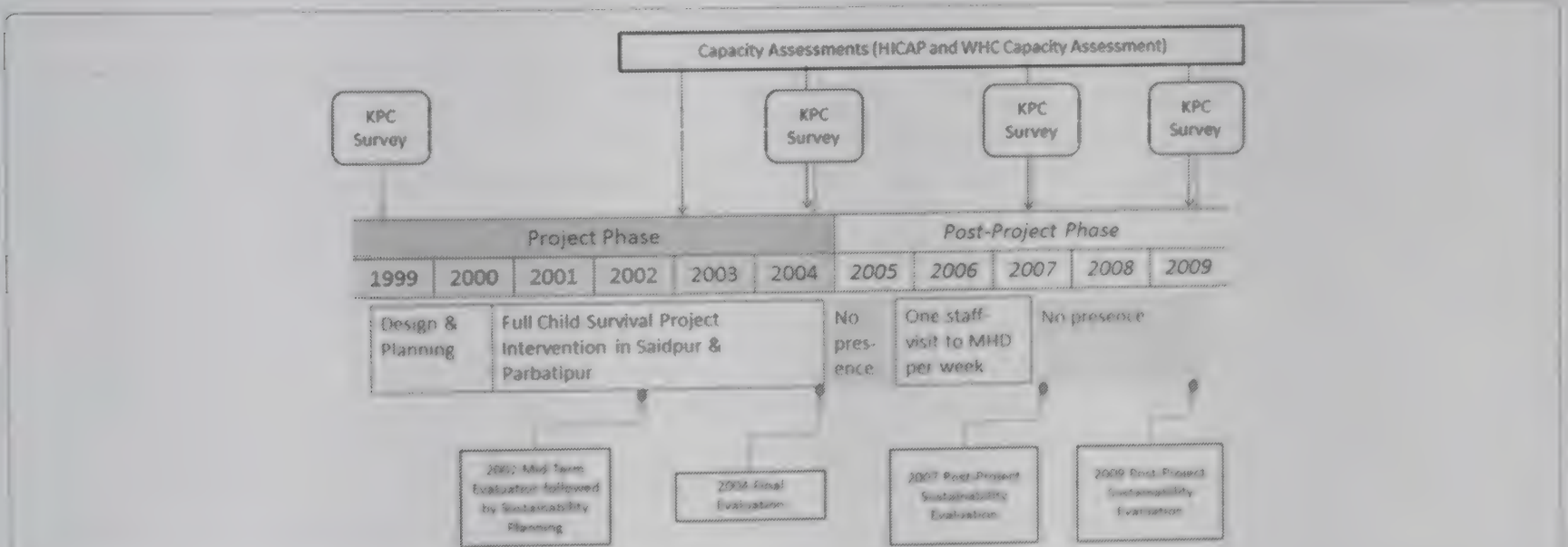
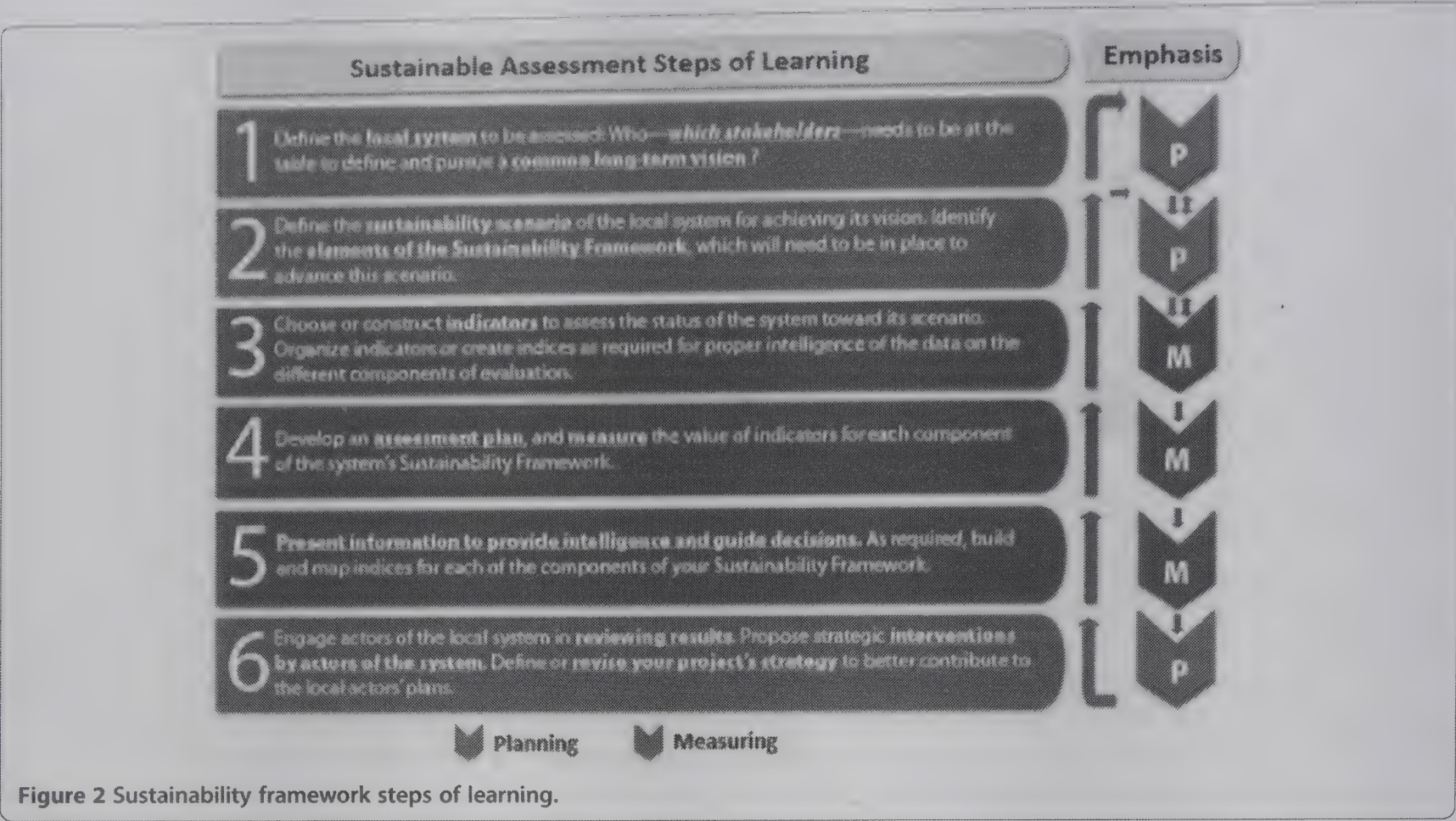


Figure 1 Implementation and evaluation phases of the Saidpur and Parbatipur Child Survival Project.



2) *Describe scenarios to achieve the vision, define the elements of the Sustainability Framework and their indicators (Steps 2 and 3)*

Although the language of ‘scenarios’ was not prominent at the time of Concern’s initial planning efforts, the project helped partners envision not only a workable future but also rational roles for all parties in order to ensure population health benefits were sustainable by local stakeholders. The vision and unfolding strategy were designed to integrate equity issues at the onset. Cognizant of the care-seeking barriers faced among the poorest urban dwellers, Concern sensitized elected leaders at the municipality and community levels of the importance of including all people irrespective of ethnicity or class in health promotion efforts. Leaders were encouraged to provide special assistance such as arranging transport, seeking support of an absent husband, accompanying the client to the health facility, and/or negotiating of fees and payments to those in greatest need.

The Sustainability Framework examines inter-dependent components of evaluation considered essential to sustaining health outcomes, each component including different elements. Following this, in the first step, Concern and the municipalities defined which elements of the Sustainability Framework fit their situation, and for each they defined how measurements or assessments would be carried out. Discussion and participation was maximal in defining what should be measured and which issues were of importance to achieve sustainable health outcomes. However, Concern

project leaders and facilitators certainly played a leadership role in proposing indicators, and ensuring that knowledge, practice, and coverage (KPC) indicators, for example, aligned with international standards. Definition of capacity indicators and statements combined different participatory and expert influences, as described below:

- Health outcomes themselves were assessed through repeated small sample, population-based KPC health surveys [35,36]. KPC surveys with samples of 350 to 600 mothers of children 0 to 23 months had been carried out at the onset of the project (1999) and were repeated at the end of the project (2004), and again in 2007 and 2009. Practice and coverage indicators provided the hard benchmarks to assess success or failure, as they directly reflected benefits to the population. During the process, elected leaders were challenged about inclusiveness and the participation of all community members in health promotion efforts, irrespective of ethnicity or class^b.
- Capacity of both municipalities was assessed through the Health Institution Capacity Assessment Process (HICAP). The HICAP is a participatory, organizational self-assessment developed by Concern with staff from the municipal health departments [34]. The final selection of domains and indicators of capacity assessment was carried out by combining an appreciative inquiry approach and commonly available organizational assessment tools.

- The HICAP was then carried out with cabinet members, ward commissioners, and the health department of both municipalities in 2004, 2007, and 2009. Non-project staff at Concern led assessment workshops in Bangla, taking 3 days per municipality. The HICAP describes progress towards an “ideal capacity”, as defined by the municipality leaders through “possibility statements”. These statements provide norms of institutional behavior, as scored on a five-point scale and based on dialogue and consensus among participants.
- The Sustainability Framework considers institutional viability as related to but distinct from capacity; *“Organizational Viability, relates not only to financial viability, but also to other essential types of support and relationships—connectedness—which an organization depends on to fulfill its mission”* [16]. Through collective reflection and analysis, viability elements were identified in the model, such as Mayor-Ministry of Health collaboration and resource leveraging. Given that the project relied heavily on the leadership of the elected mayors, councilors, and their political party, the discussion of the viability of the model made clear that steps were needed to “neutralize” the political risks, and to ensure the continuity of support beyond the current municipal administrations. Local actors involved in the sustainability planning phase helped Concern take steps ranging from informing political leaders about the role of Municipalities in health promotion during the elections and promptly orienting successful candidates shortly after elections, to helping the WHCs to uphold an apolitical identity in their neighborhoods.
- The project and its partners identified the capacity of WHCs as the main proxy measure for the community. Concern developed the WHC Capacity Assessment tool, similar in structure to the HICAP, and used by the 24 Saidpur and Parbatipur WHCs in June 2004, April to June 2007, and again in 2009 to assess their own capacity. The WHC Capacity Assessment tool was informed by the HICAP development process and the national terms of reference for the WHCs. The dimensions of assessment and indicators were validated during stakeholder consultations with the municipal cabinets, health departments, and two purposively sampled WHCs in each of the municipalities. Reviews were conducted in Bangla and Urdu by trained facilitators from the project staff (in 2004) and then by municipal constituents (in 2007 and 2009). The 1-day sessions included guided discussions, followed by scoring capacity areas on a five-point scale. Areas of assessment included not only the WHC’s internal operations but also the inclusiveness of all

socio-economic groups and efforts extended toward vulnerable community members and CHVs. Assessment of CHV’s coverage and retention began in 2007, but specific measures of their activities and qualities of their interventions were unfortunately not systematically monitored.

- The Sustainability Framework further challenged implementers to consider socio-economic threats that could undermine efforts towards a viable health intervention. Recurrent seasonal neighborhood flooding and cultural issues were identified as significant impediments to the desired collective vision. These impediments were addressed through providing a clear role to WHCs in coordination with emergency response and water and sanitation efforts. Additionally, provisions were made to increase social support for decision-making when a woman and/or child required immediate health care in the absence of the husband, and to generate parental and community support to allow mostly young and female CHVs to fulfill their home visit duties.

3) *Develop and implement the assessment plan (Step 4) and engage stakeholders in analysis and decision making (Steps 5 and 6)*

Both the final evaluation (2004) and the post-project sustainability assessments (2007 and 2009) involved iterative sequences of participatory evaluation steps:

- Formation of an evaluation team with Concern and municipality participants, under the guidance of an external lead evaluator.
- Analysis of surveys (health survey, capacity assessment) and available secondary data.
- Review, framing, and clarification of evaluation questions.
- Interviews of key informants, individually and through group discussions, including the mayor, cabinet members/WHC Chairs, Health Inspector, Municipal Health Staff, past and current CHVs, MOH partners, Ministry of Local Government, WHCs members, the Municipal Essential Service Package Coordinating Committee, and non-governmental health sector partners.
- Participatory review of findings, including a discussion on conclusions and next steps.

Results and discussion

Post-project achievements

From the moment Concern and the Municipalities took stock of mid-term achievements versus risks for

The overall findings of the 2009 post-project sustainability evaluation was largely positive: “From 2004 (end of the project) to 2007 (first post-project sustainability evaluation), in spite of a near total [98%] reduction of external inputs, the municipalities were able to maintain

Table 2 presents the evolution of 11 indicators compared to national urban trends during and after the project. We can summarize the table as changes observed during and after the life of the project:

- These 11 coverage indicators showed notable improvements during the life of the project. The 2004 final evaluation reviewed possible confounding factors to the attribution of results to the project and was supportive of a substantial attribution of

			Country comparisons (urban & national average)					
	Indicator		1999	2004	1999–2004 diff (P value)	2007	2009	2004–2009 diff (P value)
Child Health	Complete immunization	S&P*	44%	91%	<0.05	90%	91%	NS
		urban	70%	81%		86%		
	Vitamin A supplementation	S&P	37%	78%	<0.05	71%	79%	NS
		urban	76%	85%		90%		
	Exclusive breastfeeding	S&P	55%	72%	<0.05	70%	73%	NS
		nat'l	42%	36%		43%		
	Complementary feeding of children 6 to 11 months	S&P	46%	64%	<0.05	64%	65%	NS
		nat'l						
	Additional feeding and fluids for the sick child	S&P	25%	44%	<0.05	34%	25%	<0.05
	Additional fluids (only) for the sick child	nat'l	50%	52%		38%		
Proper child acute respiratory infection identification and referral	S&P	24%	34%	<0.05	66%	52%	<0.05	
	urban	48%	35%		49%			
Maternal & Neonatal Health	At least one prenatal consultation during last pregnancy	S&P	59%	89%	<0.05	87%	95%	NS
		nat'l	37%	56%		60%		
	At least three prenatal consultation during last pregnancy	S&P		64%		62%	74%	<0.05
		nat'l	25%	27%		32%		
	At least one tetanus toxoid dose during last pregnancy	S&P	46%	89%	<0.05	57%	70%	<0.05
		urban	88%	88%		84%		
	Delivery by skilled attendant	S&P	31%	50%	<0.05	56%	59%	<0.05
		nat'l	22%	13%		18%		
	Delivery in health care facility	S&P	25%	45%	<0.05	49%	57%	<0.05
		nat'l	8%	9%		15%		
Immediate breastfeeding	S&P	26%	57%	<0.05	50%	64%	NS	
	urban	23%	22%		41%			

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effect to the project [34]. Impact on equity was only taken into account by Concern in a follow-on project in seven municipalities. However, coverage indicators for Saidpur and Parbatipur in 2004 (end of project) among the poorest 20% of surveyed households were two to five times that of the 2005 baseline estimates in the seven neighboring municipalities. Given the relative comparability of the initial and expansion municipalities, this could suggest that impact in Saidpur and Parbatipur had been far from negligible among its poorest population.

- By the time of the post-project sustainability evaluations (2007 and 2009), the main point of the evaluation shifted from the project to providing information to the municipalities themselves about progress toward their vision of sustainable health. Questions of attribution of results to the original project itself became less critical. As shown in Table 2, the initial improvements in 11 indicators of maternal and child health realized during the project (1999 to 2004), 9 were maintained or improved during the 5 years post-project, even though external funding dropped to almost zero over this period^c. In only two cases did an indicator worsen between 2004 and 2009.

Self-assessment of capacity at the MHDs, using the HICAP tool, progressed substantially from the 2002 to 2003 baseline assessments to the end of the project (2004). By 2007, the scores on the HICAP faced a ceiling effect. The assessment had, however, helped guide and institutionalize the basic functions and operations required of the MHDs to support health promotion in the community, including through small amounts of financial support to each WHC.

The 2009 assessment revealed maintenance of the structure and basic functions of the WHCs, along with weaknesses in their operations. All WHCs had maintained a bank account with a solid balance. They mobilized additional resources and obtained financial support from the municipalities for special events, as well as emergencies affecting the poorest members of the community. WHCs, nonetheless, expressed dissatisfaction with the inconsistent support from municipalities.

While performance issues at the WHC level and in the WHC support of CHVs were identified, the human infrastructure continued to operate at the time of the 5 year post-project sustainability assessment (2009), despite a high degree of national political instability and the food price crisis of 2007 to 2008. The diversification of perspectives from diverse actors through the sustainability assessment phase allowed avoiding the natural bias of representation (male, elite) within the WHC and led

WHC membership to be more representative of all segments of the neighborhood (i.e., class, ethnicity, education level, gender, and political affiliation). Additionally, having formed a vision of a desirable public good with a diverse group of stakeholders, the project was able to involve them in informing political party leaderships (both in power and opposing) about the role of WHCs and the Councilors. By the time of the post-project sustainability assessment, most WHCs had gone through a change of Chairpersons following municipal elections, but continued operating as largely apolitical institutions dedicated to promoting the common good.

Sustainability needs to be assessed as resulting from a local system's process, not an end-point

Concern worked with stakeholders and generated a process-within-a-system. The level of sustainability achieved was a partial achievement. It proceeded from also partial but expressed capacity, collaboration, coordination, occasional cooptation, some loss of energy but maintenance of key elements, such as operations of the WHCs and CHVs. While efforts of different parties may have been imperfect, they aimed to contribute to a recognized public good (preventive health outcomes). Essentially, sustainability occurred as a process supported by a network of system agents^d.

Concern clearly encouraged this by stepping out of direct implementation and very rapidly supporting local stakeholders in negotiating their long term roles. The project not only aligned to a national policy, but since it had not been implemented on the ground, it operationalized it and helped local stakeholders in giving it substance.

The fact that both mayors and most elected officials participated in the sustainability assessment 5 years after the end of activities speaks of the ownership that was created. This was built through very intense and persistent efforts at "accompanying", or softly leading councilors, staff, WHC members, and volunteers in the early phases of the project.

Interestingly, the approach of Concern, supported by a planning and evaluation tool for sustainability, can be compared to systems thinking design steps highlighted in the Alliance for Health Policy and System Research's "flagship publication" [6]: 1) The project convened stakeholders repeatedly and at every step. 2) Concern led not only collective brainstorming but also helped stakeholders define the road ahead, the modes of monitoring and evaluation, down to the indicators when possible, and then jointly review findings (not just with the leaders and experts). 3) The definition of elements of the Sustainability Framework provided a conceptual map of expected results and scenarios for progress. 4) The iterative steps of assessment, action, and reviews allowed a

measure of adaptation at each step. The last post-project sustainability evaluation showed, to some extent, how this assessment for action principle had been institutionalized by the municipality partners. While Concern had stopped all involvement in the municipality for some years at this point, apart from the evaluation itself, stakeholders largely self-organized and decided to work into the evening to define their response to the findings of the sustainability evaluation.

The sustainability framework did not offer a perfect measurement tool, but served the role of a local systems thinking and learning tool

The ongoing learning through the project phases of implementation and assessment took place despite some elements of the Sustainability Framework lacking measures. For example, indicators of community capacity focused on community-based organizations (WHCs) but failed to capture larger social processes and social capital formation, probably elements of equal if not greater import. The literature suggests that this remains a challenge especially outside of research programs [38].

Some components of the Sustainability Framework are more amenable to standard, reliable measures than other components, assessed through softer methods. It is the resulting combined evidence which allowed actors of the system to engage in systems thinking and making sense of the data:

- Proxy measures of health outcomes are well codified through both demographic and health surveys [27-29] and small population surveys [35], such as the KPC Survey used by Concern [36].
- The HICAP results were initially extremely useful in identifying structural weaknesses in the urban health institutional infrastructure. The heavy investment of the municipalities in refining and adapting the tool, while it did not allow for standardization, provided strong buy-in and critical reflection from participants on their collective capacity, even if the benefit of the tool waned by 2009 (due to ceiling effects and lack of new information provided by the tool).
- The consideration of viability and social-economic environment forced a wider perspective in analyzing how the external health intervention plays out in the development context. The tool required the project to consider inter-relationships between municipal authorities, the Ministries of Health, and civil society. The process assisted stakeholders in vetting risks to the health promotion efforts and give them higher priority in their efforts than they would have otherwise. For example, flood mitigation measures and female mobility for both CHVs and health referrals became central tenants of the community

mobilization strategy, even if they had not been explicit mandates of the original project.

The Sustainability Framework provided a tool and a method to engage stakeholders in learning evidence-based steps. Two features of the tool proved useful:

- Being systematic is a content issue: the Sustainability Framework helped users to consider distinct dimensions of progress systematically, each with defined content elements and corresponding measures. The identification of the components of the model had strong face validity and remained meaningful to local stakeholders throughout the process.
- Being systemic is a process issue: the Sustainability Framework considered a local system and, before focusing on measures of capacity and performance, sought to understand the relationships, both existing and those to be negotiated, between the members of the system.

The process for fleshing out the content of the planning or evaluation model is one which requires connections and interplay between diverse and interdependent entities in the system (i.e., the WHCs and the MHD). In so doing, stakeholders also are encouraged to interact and, if using the iterative process, over time, build some common language, trust, and goals (social capital) [39].

A crucial step in this process was the development of a common vision by all stakeholders and the continuous reference to the shared mandate it created. A system of local actors possibly lacking coherence, common currency, trust, and positive experience of joint achievements will be limited in the vision it can frame. In Saidpur and Parabatipur, this process was facilitated greatly by Concern at the onset. By the 5-year post-project period, key elements of that vision were still shared and alive (the existence and importance of WHCs and volunteers, the need to support the most vulnerable citizens from the worst shocks). The fact that the local vision built on the realization of a national policy certainly helped local actors to define and embrace it initially; but by the time of the final study, it was maintained not by the will of a fairly absent central government, but by its meaning to local actors.

Ownership is inherently challenged by external assistance; early consideration of sustainability and a systems approach to sustainability evaluation can mitigate this risk

An inherent tension has existed between the concepts of external assistance and local ownership over the course of the last 70 years of development assistance. The

Sustainability Framework does not pretend to offer the solution to this quandary, but it does support a local system of actors exploring different visions and possibilities for a more successful pursuit of a common goal. It also helps external actors become change agents of and contributors to this system. It offers a way to reduce the displacement of ownership, which money naturally brings to resource-constrained environments.

The initial focus on defining the system, bringing different groups to the table, and trying to build a common vision and compatible scenarios are possibly the most important learning steps advanced by the Sustainability Framework, along with regular monitoring and reviews. Through iteration of measures, negotiation and decision making, the process required by the Sustainability Framework can help the local system adapt to successes, to new events, and shocks. Sustainability means that the system is able to conceive of, then realistically adapt and develop new ideas, thus transforming or evolving the scenario its members initially imagined.

Saidpur and Parbatipur clearly reached a stage where new options were conceivable to them through an institutional infrastructure which reached their most vulnerable members. The sustainability assessment identified choices, which municipalities had to make to seize on these options.

Conclusions

The challenge for Concern was to provide an ongoing evaluation process which would be evidence-based, allow effective implementation of interventions by municipal structures, and inform the social and health system actors about progress toward sustainable health achievements.

The process of joint visioning, planning, implementation, monitoring, assessment, review, and decision-making provided Saidpur and Parbatipur with a systematic, if perfectible, approach to do this. The answer made sense to the local actors from communities and municipalities, including health officials who participated in the sustainability evaluation. In the end, the Sustainability Framework played maybe its most important role as a tool for engagement of and negotiation between local stakeholders. It offered a guide to self-learning and decision-making with an evidence-based focus on objectives and tangible public good (health indicators, WHCs, and CHV activities).

Social, political, and organizational systems have the particularity of being purposeful complex adaptive systems^d [40], which means that agents are endowed with some level of free will to define their own individual strategies within a system, based on information received about other agents' behaviors. A systems approach, operationalized through the Sustainability Framework, reduced the tension in balancing sustainability and equity.

As all key stakeholders were present and engaged in the framing of a vision inclusive of equitable concerns, the development of action plans and metrics of success had to include prioritization of the neediest. Furthermore, the constant reference to data, metrics of progress understood by all, referring back to a long-term vision repeated with constancy and visualized in assessment reports, allowed the construction of what Geyer and Rihani call a "societal framework" through which the value of the public good being pursued is reinforced for all [41].

Development aid's efforts at scale up and acceleration of achievements are known to create stress on country systems, regardless of good intentions. This makes the question of sustainability still enormously critical to the future of global health and global development [42,43]. Development projects too often deal with sustainability as a false promise or a utopia, with statements such as, "*the project will ensure sustainability three years from now by...*"; this does not lend itself to shared accountability for progress on an authentic process worth the efforts of beneficiaries, country stakeholders, project designers, implementers, and donors. Commitment to sustainability requires us to approach more honestly and rigorously its unfortunate complexity. And as illustrated in the section "A systems understanding of sustainability," we are still learning to recombine or create tools to effectively use "systems thinking" on complex issues such as ownership, scale, and sustainability [43-45]. We hope to have illustrated the value of one such approach.

Finally, given the evidence for the challenging conditions under which sustainability can develop at local levels and the time this requires, national governments themselves, with or without foreign aid, will benefit from more methodical and systems-oriented planning evaluation methods to a complex but essential question.

Endnotes

^a<http://www.coregroup.org/about-us/history-of-core-group>

^bIn a follow-on project in new municipalities, Concern added a module to the external baseline and final household surveys, allowing comparison of health outcomes across proxy wealth quintiles [46].

^cWith the exception of a USAID-supported project promoting facility deliveries, during the life and after the end of the project.

^dA discussion of complex adaptive systems behaviors of both municipalities and project is available [47].

Abbreviations

CHVs: Community health volunteers; Concern: Concern Worldwide Inc.; HICAP: Health Institution Capacity Assessment Process; KPC: Knowledge, practice, and coverage; MHDs: Municipal health departments; NGOs: Non-Governmental Organizations; USAID: US Agency for International Development; WHCs: Ward Health Committee

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

EGS developed the initial concept for the paper, its outline and main sections. MK lead the development of the background section, contributed to the method, the results, and discussion. SJ contributed to background, method, and findings. IR contributed to background and findings. AM contributed to background and findings. All authors read and approved the final manuscript.

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COMMENTARY

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The application of systems thinking in health: why use systems thinking?

David H Peters

Abstract

This paper explores the question of what systems thinking adds to the field of global health. Observing that elements of systems thinking are already common in public health research, the article discusses which of the large body of theories, methods, and tools associated with systems thinking are more useful. The paper reviews the origins of systems thinking, describing a range of the theories, methods, and tools. A common thread is the idea that the behavior of systems is governed by common principles that can be discovered and expressed. They each address problems of complexity, which is a frequent challenge in global health. The different methods and tools are suited to different types of inquiry and involve both qualitative and quantitative techniques. The paper concludes by emphasizing that explicit models used in systems thinking provide new opportunities to understand and continuously test and revise our understanding of the nature of things, including how to intervene to improve people's health.

Keywords: Complex adaptive systems, Complexity, Methods, Systems thinking, Theory, Tools

Background

In the rapidly changing field of global health, it is hard to know whether the recent attention to systems thinking is just another fad, or something more durable that offers usable insights for understanding and action. Some see systems thinking as providing a powerful language to communicate and investigate complex issues, while others are confused by the sizable and amorphous body of theories, methods, and tools involved. Time will tell, of course, but in the meantime, it is helpful to consider why we would use systems thinking in a field that already draws upon a rich collection of theories, methods, and tools from the health sciences, social sciences, engineering, mathematics, and other disciplines.

From mental models to explicit ones

At its core, systems thinking is an enterprise aimed at seeing how things are connected to each other within some notion of a whole entity. We often make connections when conducting and interpreting research, or in our professional practice when we make an intervention with an

expectation of a result. Anytime we talk about how some event will turn out, whether the event is an epidemic, a war, or other social, biological, or physical process, we are invoking some mental model about how things fit together. However, rather than relying on implicit models, with hidden assumptions and no clear link to data, systems thinking deploys explicit models, with assumptions laid out that can be calibrated to data and repeated by others. The word system is derived from the Greek *sunístánai*, meaning "to cause to stand together." If we consider that a system is a perceived whole, made up of parts that interact toward a common purpose, we recognize that the ability to perceive, and the quality of that perception, is also part of what causes a system to stand together. Systems thinking is intended to improve the quality of those perceptions of the whole, its parts, and the interactions within and between levels.

Every interpretation of a research result involves a model, whether it is a physical model used for experimentation, a statistical model used to estimate the relationships between variables, or a conceptual model about how elements are connected. A model is simply a way we compactly represent and understand an object, phenomenon, or system. As much as research involves observation and experimentation, I would argue that good research is also

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about building and using explicit models rather than implicit ones. The real question is not whether we should be using systems thinking, as broadly described here, but rather, which of the many theories, methods, and tools currently associated with the field of systems thinking are most useful in particular settings.

For example, where individual people interact directly with one another (e.g., transmitting disease) while moving about in an explicit space such as a city, agent-based modeling [1,2] may be especially powerful. In modeling how different agencies within a large public health system interact, social network theory [3] could be more directly relevant.

Origins

Systems thinking has largely developed as a field of inquiry and practice in the 20th century, and has multiple origins in disciplines as varied as biology, anthropology, physics, psychology, mathematics, management, and computer science. The term is associated with a wide variety of scientists, including the biologist Ludwig von Bertalanffy who developed General System Theory; psychiatrist Ross Ashby and anthropologist Gregory Bateson who pioneered the field of cybernetics; Jay Forrester, a computer engineer who launched the field of systems dynamics; scientists at the Santa Fe Institute, such as Noble Laureates Murray Gell-Mann and Kenneth Arrow, who have helped define complex adaptive systems [4]; and a wide variety of management thinkers, including Russell Ackoff, a pioneer in operations research, and Peter Senge, who has popularized the learning organization. Much of the work in systems thinking has involved bringing together scientists from many disciplinary traditions, in many cases allowing them to transfer methods from one discipline to another (inter-disciplinarity), or to work across and between disciplinary boundaries, creating learning through a wide variety of stakeholders, including researchers and those affected by the research (trans-disciplinarity).

Theories, methods, and tools

If there is a jungle of terminology used to describe scientific endeavor, it gets even thicker in the area of systems thinking, perhaps because of its diverse heritage. Given the varied disciplines and trans-disciplinary traditions involved, it is easy to see why people often talk about broader “approaches”, “perspectives”, or “lenses” when applying systems thinking. Systems thinking models and frameworks are sometimes grand and widely applicable, such as General System Theory, and at other times very specifically applied to particular phenomena, such as the theory on critical points in physics, which is used to explain the point at which a material behaves as neither liquid or gas (or solid). Systems thinking can involve a wide range of theories, which are rational sets of ideas or

principles intended to explain something. It is based on a wide variety of scientific methods used to investigate phenomena and acquire knowledge. It uses an even larger array of instruments or tools – the hardware and software used to conduct experiments, make observations, or collect and analyze data. The use of these terms is not consistent across or within scientific fields, including systems sciences, and the continuum from tool to method to theory and framework is often blurry.

Rather than attempt to sort out semantic nuances between these terms, the utility of systems thinking can be better appreciated by a brief look at some of its more commonly used theories, methods, and tools (Table 1). The theories and methods in systems thinking are each designed to address complex problems. They are complex because they involve multiple interacting agents, the context in which they operate keeps changing, because the manner in which things change do not conform to linear or simple patterns, or because elements within the system are able to learn new things, sometimes creating new patterns as they interact over time. Many of the challenges in global health are now recognized as complex problems where simple blueprint approaches have limited success [5,6].

Systems thinking tools have a wide variety of applications. Some tools are intended as means of facilitating groups of people to have a common understanding about an issue to prompt further inquiry and action. For example, “systems archetypes” help teams to understand generic patterns of interaction that can be applicable to their “story” [24]. Rather than use the pre-existing templates of systems archetypes, causal loop diagrams (CLD) are created without a template, and involve drawing out people’s understanding of how elements of a problem are related to each other [19]. They usually begin as qualitative descriptions outlining how one thing causes another in either a positive or negative direction. Typically, feedback loops are identified between the different elements. They can be reinforcing or positive feedback loops, where A produces more B which in turn produces more A, such as the vicious cycle of under-nutrition and infection. They can also be balancing or negative feedback loops, where a positive change in one leads to a push back in the opposite direction, such as when increasing body temperature produces sweating, which in turn cools down the body. In this supplement, a number of studies use CLDs that describe relationships between different elements of a health system to explain phenomena such as dual practice of health workers in Uganda [25], provider payment systems in Ghana [26], and childhood vaccination coverage in India [27].

The elements of a CLD might also be converted into a quantitative systems dynamics model by classifying the elements as “stocks”, “flows”, or “auxiliary” variables, and using equations to describe the relationships between individual variables in one of many available systems

Table 1 Systems thinking theories, methods, and tools

Name	Purpose and description	Key reference
Theories		
Catastrophe theory	A theory in mathematics and geometry to study how small changes in parameters of a non-linear system can lead to sudden and large changes in behavior of a system.	Poston & Stewart [7]
Cybernetics	Historically used as a synonym for systems theory, it is a field of study of the communication and control of regulatory feedback in both living and non-living systems (e.g., organizations, machines).	Ashby [8]
Chaos theory	A field of study in mathematics with applications in a wide number of disciplines to explain a dynamic system and that is highly sensitive to the initial conditions, so that small changes in initial conditions produce wildly different results. The changes occur through fixed rules about changing relationships, and without randomness.	Strogatz [9]
General systems theory	Less of a theory than a way of finding a general theory to explain systems in all fields of science. It was not intended to be a single theory of systems, but more of a systematic inquiry into different domains of philosophy, science, and technology.	van Bertalanffy [10]
Learning organizations theory	A description of organizations that facilitate learning by its members and continuously transforms itself. Systems thinking approaches are the conceptual basis for understanding the organization in its environment, and provides a basis for other key characteristics, namely a process of learning (personal mastery), the challenging and building of mental models, and the development of a shared vision and team learning.	Senge [11]
Path dependency theories	Occurs in economics, social sciences, and physics, and refers to the explanations for why processes can have similar starting points yet lead to different outcomes, even if they follow the same rules, and outcomes are sensitive not only to initial conditions, but also to bifurcations and choices made along the way.	Arthur [12]
Punctuated equilibrium (in social theory)	Theory inspired from evolutionary biology [13] to explain long periods of stasis interrupted by rapid and radical change, particularly as applied to the evolution of policy change or conflict.	Baumgartner & Jones [14]
Methods		
Agent-based modeling (ABM)	ABMs are used to create a virtual representation of a complex system, modeling individual agents who interact with each other and the environment. Although the interactions are based on simple, pre-defined rules, in a complex system these simulations allow for the identification of emergence and self-organization.	Epstein [15]
Network Analysis (or Social Network Analysis)	Network analysis uses graphical methods to demonstrate relations between objects. Grounded in computer science, it has applications in social, biological, and physical sciences. Social network analysis involves application of network theory to social entities (e.g., people, groups, organizations), demonstrating nodes (individual actors within a network), and ties (the type of relationships) between the actors, and uses a range of tools for displaying the networks and analyzing the nature of the relationships.	Newman [3]; Valente [16]
Scenario planning	This is a strategic planning method that uses a series of tools to identify and analyze possible future events and alternative possible outcomes. These can involve quantitative projections and/or qualitative judgments about alternatives. The value lies more in learning from the planning process than the actual plans or scenarios.	Schoemaker [17]
Systems dynamics modeling	Not a single method, but an approach that uses a set of tools to understand the behavior of complex systems over time. The methods focus on the concepts of stocks and flows and feedback loops. They are designed to solve the problem of simultaneity (mutual causation) by being able to change variables over small periods of time while allowing for feedback and various interactions and delays. The common tools include causal loop diagrams and stock and flow diagrams.	Forrester [18]
Tools		
Causal loop diagrams (CLDs)	CLDs are a system dynamics tool that produces qualitative illustrations of mental models, focused on highlighting causality and feedback loops. Feedback loops can be either reinforcing or balancing, and CLDs can help to explain the role of such loops within a given system. CLDs are often developed in a participatory approach. The drawings can be further developed by categorizing the types of variables and quantifying the relationships between variables to form a stock and flow diagram.	Williams & Hummelbrunner [19]
Innovation (or change management) history	Innovation or change management history aims to generate knowledge about a system by compiling a systematic history of key events, intended and unintended outcomes, and measures taken to address emergent issues. It involves in-depth interviews with as many key stakeholders as possible to build an understanding of the performance of the system from a number of different points of view.	Douthwaite & Ashby [20]
Participatory Impact Pathways Analysis (PIPA)	PIPA is a workshop-based approach that combines impact pathway logic models and network mapping through a process involving stakeholder engagement. PIPA workshops aim to help	Alvarez [21]

Table 1 Systems thinking theories, methods, and tools (Continued)

	participants to make their assumptions and underlying mental models about how projects run explicit and to reach consensus on how to achieve impact.	
Process mapping	A set of tools, such as flow charts, to provide a pictorial representation of a sequence of actions and responses. Their use can be quite flexible, such as to make clear current processes, as a basis for identifying bottlenecks or inefficient steps, or to produce an ideal map of how they would like them to be.	Damelio [22]
Stock and flow diagrams	Stock and flow diagrams are quantitative system dynamics tools used for illustrating a system that can be used for model-based policy analysis in a simulated, dynamic environment. Stock and flow diagrams explicitly incorporate feedback to understand complex system behavior and capture non-linear dynamics.	Sterman [23]
Systems archetypes	Systems archetypes are a number of generic structures that describe common behaviors between the parts of a system. They provide templates to demonstrate different types of balancing and reinforcing feedback loops, which can be used by teams to come to a diagnosis about how a system is working, and particularly about how performance changes over time.	Kim [24]

dynamics software environments. In this supplement, Rwashana and colleagues use systems dynamics models to examine neonatal mortality in Uganda [28], while other authors use systems dynamics models to examine the effects of policy interventions [29].

There are number of other tools that are used to map out events or how things are connected. Network mapping, social network analyses, and process mapping involve a range of tools to illustrate and analyze connections between people, organizations, or processes in both qualitative and quantitative ways. In this supplement, Malik et al. map out the network of actors involved in physician’s seeking advice in Pakistan [30]. The flow chart is one of the more common tools used to draw a process or a system. Innovation history (or change management history) is used to compile a history of key events, outcomes, issues that have cropped up along the way, and measures taken to address problems. In this supplement, Zhang et al. [31] look back over the last 35 years of the development of the medical system in rural China. Participatory Impact Pathways Analysis involves workshops and a combination of tools to clarify the logic of interventions and a mapping of the network [21]. It is intended to enhance understanding through participation with beneficiaries, implementers, and other stakeholders in a project. Several papers in this supplement use similar approaches for a variety of situations, including to build leadership capacity for health systems in South Africa [32], to develop sustainable physical rehabilitation programs in Nepal and Somaliland [33], and to build sustainable maternal and child preventive health services in Northern Bangladesh [34].

Agent based modeling takes advantage of a wide variety of theories, methods, and tools to build computer models that simulate the interaction of agents (e.g., individuals or organizations) to see how real world phenomena “grow” and affect the system as a whole. The models involve multiple individual agents that work at different scales, some decision-making rules (e.g., simple rules on how they

reproduce, interact with others or pursue objectives), processes for adaptation, and a space in which the agents operate.

In global health, we are concerned with both theory and practice, and are in need of models that match the complex conditions in which we work. A common thread of all these theories, methods, and tools is the idea that the behavior of systems is governed by common principles that can be discovered and expressed. They are all helpful in trying to conceptualize the systems in place. Some are more focused on ways to change the system to produce better outcomes. In using these theories, methods, and tools, we are reminded by the statistician George EP Box that “*all models are wrong, but some are useful*” [35]. It is to these uses that we now turn.

In much of public health and medicine, we use research evidence on the efficacy of interventions to inform decisions with an expectation about their future effect. Some systems thinking methods and tools, such as scenario planning, can also be used to explicitly forecast future events. However, even then, such methods are intended to be used for identifying possible outcomes to provide insights on how to prepare for them rather than fixing on any particular outcome.

In his landmark address on “Why Model?”, which provided inspiration for this essay, Joshua Epstein identified 16 reasons other than prediction on why to model [36]. Most of these reasons are applicable to systems thinking more broadly. Many of these specific reasons relate to being able to explain how things work, and systems thinking is particularly useful to explaining how complex systems work. Many of models can be used for testing the viability of policy interventions in a safe and inexpensive way – agent based models, systems dynamics models, and scenario planning are particularly useful for these purposes. In this journal supplement, for example, Bishai et al. present a very simple systems dynamics model to illustrate the trade-offs and unintended consequences of policy

choices related to allocation to preventive and curative services [29].

Systems thinking approaches can also provide guidance on where to collect more data, or to raise new questions and hypotheses. The methods and tools help us to make explicit our assumptions, identify and test hypotheses, and calibrate our models against real data. One of the frustrations of health planners and researchers has been the aspiration that interventions shown to be effective at small scale or in a research setting cannot be simply replicated at large scale or to reach populations that are most vulnerable. Systems thinking methods and tools are increasingly being used to explain epidemics and to inform programmatic expansion efforts [5,6].

One of the more compelling reasons to use systems thinking approaches is to inspire a scientific habit of mind. Beyond the contributions of any particular theory, method, or tool, the practice of systems thinking can reinforce what Epstein calls a “militant ignorance”, or commitment to the principle that “I don’t know” as a basis for expanding scientific knowledge. Systems thinking adds to the theories methods and tools we otherwise use in global health, and provides new opportunities to understand and continuously test and revise our understanding of the nature of things, including how to intervene to improve people’s health. And for those who value thinking and doing in global health, that can only be a good thing.

Competing interests

The author declares that he has no competing interests.

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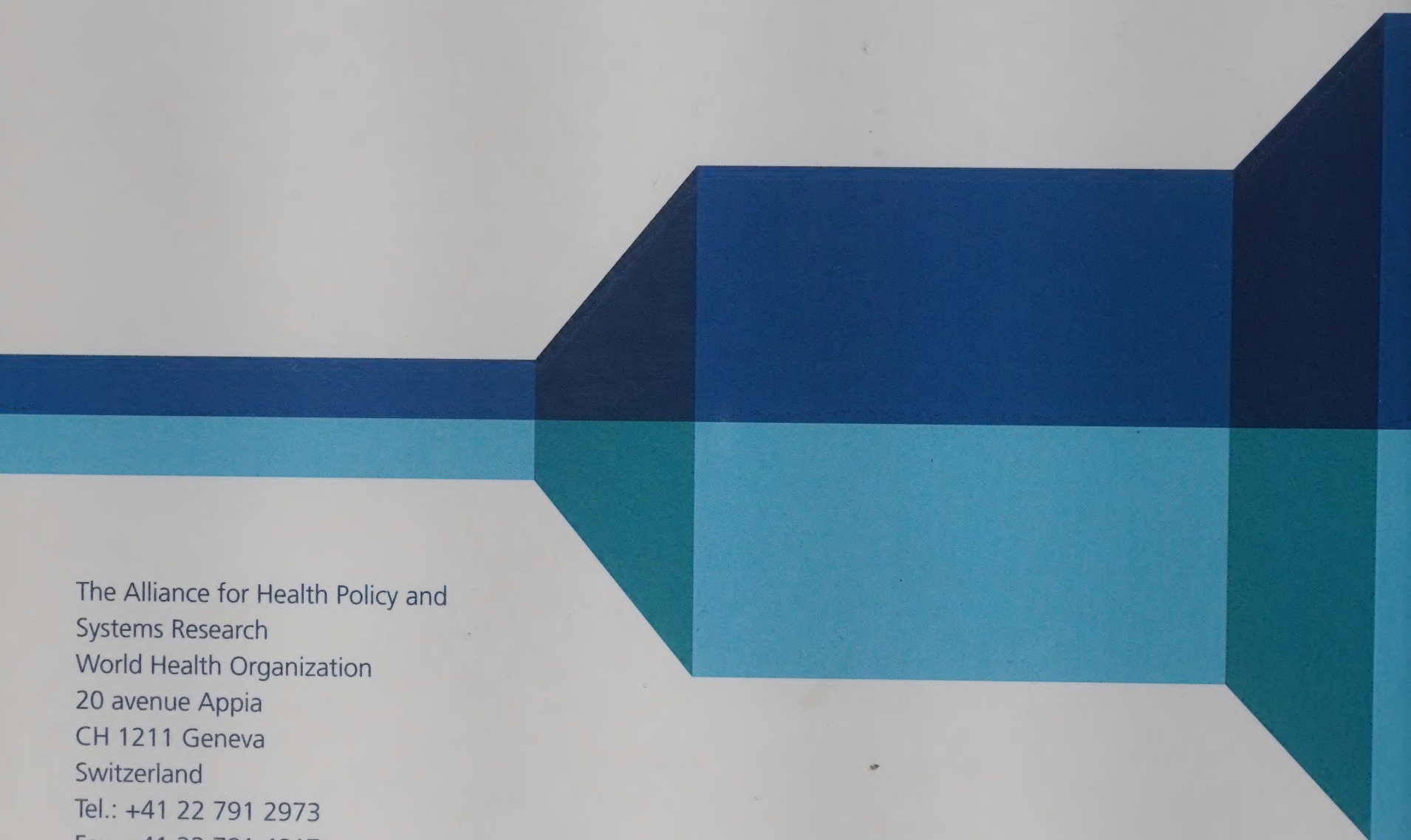
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Notes

ADVANCING THE APPLICATION OF SYSTEMS THINKING IN HEALTH

Systems thinking provides an understanding of the complexity of health systems, which is fundamental for strengthening the design, implementation and evaluation of health systems interventions, policies and strategies. The primary objective of this Series is to support the shift from abstract concepts to actual applications and experiences of systems thinking in health, particularly in low- and middle-income countries.



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